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JOURNAL of PALEONTOLOGY

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Tejon

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JANUARY, 1937

NAUTILOID CEPHALOPODS FROM THE EOCENE OF CALIFORNIA

H. E. VOKES
University of California, Berkeley, California

ABSTRACT

Nautiloid cephalopods in the Martinez formation, basal Eocene of California, include four described species referred to *Eutrephoceras*, *Hercoglossa* and *Aturoidea*, and a new species of *Hercoglossa*. The middle Eocene La Jolla formation contains a new species of *Eutrephoceras*.

Recent papers by Miller and Thompson (1) and Miller (2) have served greatly to increase the value of the nautiloid cephalopods for purposes of correlation in basal Eocene deposits. These papers prompted a study of the California species, which, other than in Schenk's study of the *Aturias* (3), have never received more than perfunctory study and have not been used for purposes of correlation.

The Martinez stage, the basal Eocene of California, was first mentioned in the literature, as the Martinez group, by Whitney (4) in 1869. The name was applied to strata in the vicinity of the town of Martinez, on Carquinez Straits, near San Francisco, California, which were considered to be intermediate between the Chico group, Cretaceous A, and the Tejon group, Cretaceous B, of Gabb. When the controversy as to the Cretaceous or Eocene age of the Tejon Group was at its height Stanton (5) studied the sequence at Martinez and concluded that a portion of the Martinez group should be referred to the Chico and a portion to the Tejon, eliminating the Martinez as a stratigraphic unit. However, in a paper published at about the same time Merriam (6) showed that the Martinez is a faunal unit which can be distinguished from the Cretaceous and overlying Eocene deposits. Dall (7), in a general correlation table, indicated that both the Martinez and the Tejon were the correlative of the Midway of the Gulf Coast and of the Cernaysian of Europe. The Tejon group, as recognized at that time, is now known to contain strata equivalent to the Sparnacian, Ypresian, Lutetian, Auversian and Bartonian of the Paris Basin sequence (7*a*). Later Weaver (8) and Dickerson (9) studied the faunas of the Martinez and correlated it with the Midway stage of the Gulf Coast, though Dickerson believed that it contained strata in part decidedly lower than the Midway, a conclusion which is not at present generally accepted. In the latter paper Dickerson described two species of nautiloid cephalopods and listed *Aturia mathewsoni* Gabb as occurring at the type locality of the formation. Strata referable to the Martinez stage are known from several distant areas in the state of California but have not been recognized at ei-

ther Oregon or Washington localities.

Other than at the type locality, nautiloids have been reported from the Martinez only in the Simi Valley, in Ventura County. Here the fauna has been studied by Waring (10), and monographed in detail by Nelson (11). Other Martinez localities have not as yet yielded specimens of these forms.

The California species do not show any appreciable evidence of close relationship with the species described from the Midway group, nor the species from Peru described by Berry (12) and by Olsson (13). The species of *Hercoglossa*, in particular, show distinctive sutural features which have not been observed in other described species. The evidence seems to indicate a degree of evolution within the Californian region.

The presence of the genus *Hercoglossa*, associated with the species of *Eutrephoceras* confirms the correlation of the Martinez and Midway formations. The genus *Cimomia* Conrad does not appear to be present in the California fauna.

During the course of this study it was necessary to investigate an undescribed species of *Eutrephoceras* from the middle Eocene La Jolla formation of southern California. This, being the only nautiloid, other than the species of *Aturia* reviewed by Schenk (3), from the Eocene deposits above the Martinez stage, is here described.

SYSTEMATIC DESCRIPTIONS

Genus EUTREPHOCERAS Hyatt, 1894

Genotype species, by original designation, *Eutrephoceras dekayi* (Morton), Navesink marl (Cretaceous), New Jersey.

EUTREPHOCERAS STEPHENSONI (Dickerson)
Plate 2, figures 12–14

Nautilus stephensoni DICKERSON, *1914*, Univ. California Publ., Dept. Geol. Sci., Bull., vol. 8, p. 150, pl. 18, figs. 2*a*,*b*.—NELSON, *1925*, idem, vol. 15, check list.

Eutrephoceras stephensoni (Dickerson), MILLER and THOMPSON, *1933*, Jour. Paleontology, vol. 7, p. 302.

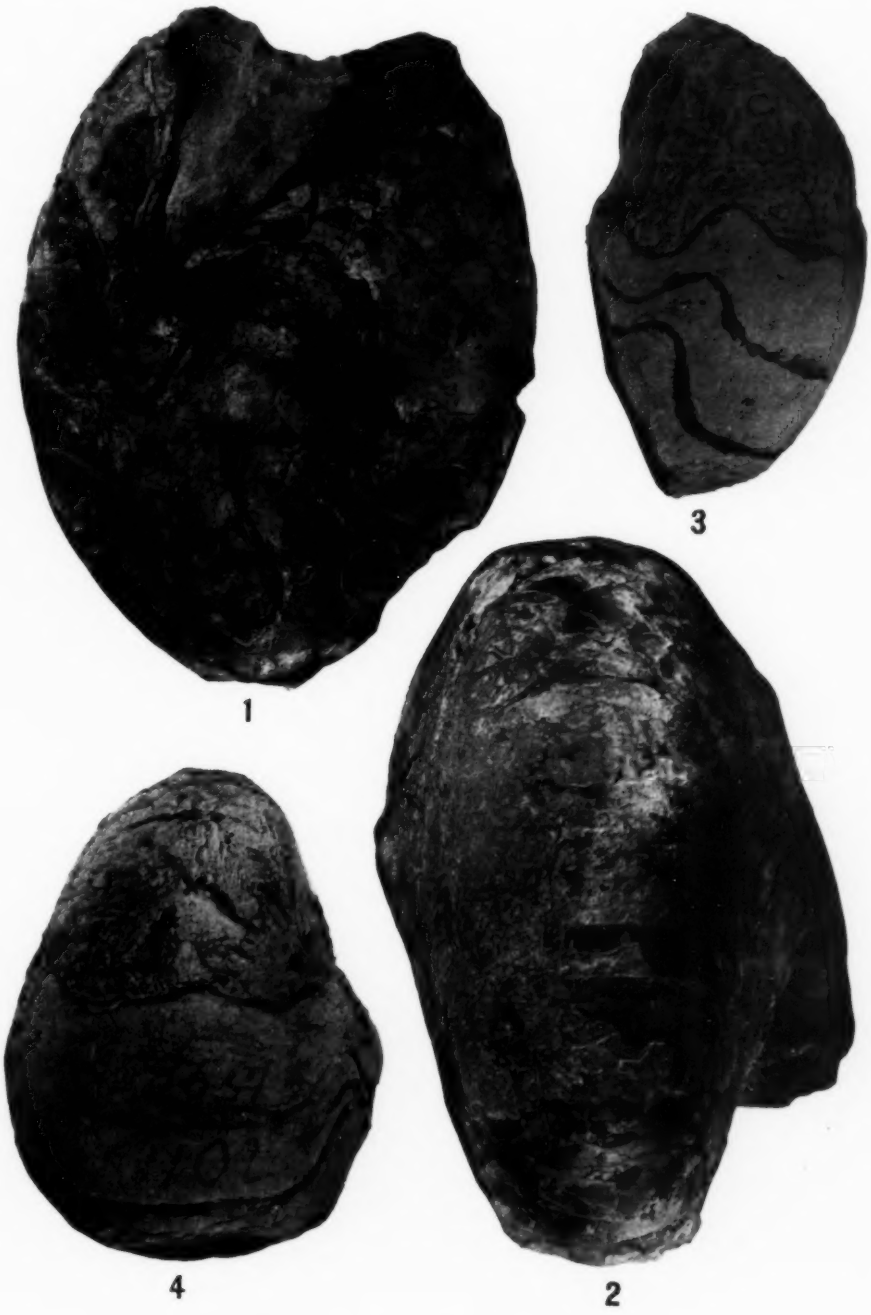
Hypotypes: Univ. California Mus. Paleont. 15982, loc. 3820; U.C.M.P. 15893, loc. 3773; Simi Hills, Calabasas quadrangle, Ventura County, California; Martinez stage, "Paleocene."

Dimensions	*15982*	*15893*
Diameter from adoral end of venter across the umbilicus	28 mm.	32 mm.
Diameter across the umbilicus at right angles to last	21.5	—
Adoral end:		
Maximum height of conch	12	17
Maximum width of conch, observed	25	23
Same, estimated	29	26
Height of conch to base of impressed area	—	11
Distance from siphuncle to venter	—	6.5
Diameter of umbilicus	9	—
Adapical end:		
Maximum height of conch	7	—
Maximum width of conch	11	—

EXPLANATION OF PLATE 1

FIGS. *1*, *2*—*Hercoglossa merriami* Dickerson, lateral and ventral views, ×0.6, of holotype, Univ. California Mus. Paleont. 15984; Martinez stage, Simi Valley, Ventura County, California. (p. 7)

3, *4*—*Hercoglossa simiensis* Vokes, n. sp., lateral and ventral views, ×1, of holotype, U.C.M.P. 15985; Martinez stage, Simi Valley, Ventura County, California. (p. 8)



Vokes, Eocene Cephalopods

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The original figure, said to be "×1," was actually ×1.5. It is a species whose members are apparently all of small size. There is in the collections at the University of California a fragment of a very large specimen from the Martinez formation near Selby station, California, which may represent this species. The greatest width of the conch was 85 mm., and the distance from the venter to the base of the impressed area over 30 mm. It is too globose to be referable to *E. hallidayi*, but is too imperfect to permit definite specific determination.

Additional descriptive notes.—The whorls are reniform in cross section, broadly rounded ventrally and laterally, and moderately impressed dorsally. As indicated in the original figure the umbilicus, while small, is not covered; the umbilical shoulders are broadly rounded, and the walls steep. The surface of the shell is smooth, the "sinuous lines of growth" mentioned in the original description indicate a broad, shallow, rounded hyponomic sinus. The sutures are somewhat more sinuous on the adapical portion of the volution than on the later stages, the trend being apparently toward the development of an almost straight suture. The siphuncle is rounded, situated on the upper third of the distance between the venter and the impressed area.

E. stephensoni is similar in general outline to *E. jonesi* Miller and Thompson (1*a*), but appears not to approach the size attained by that species. *E. hannai* Vokes, n.sp., differs in possessing a straight suture and is somewhat more globose.

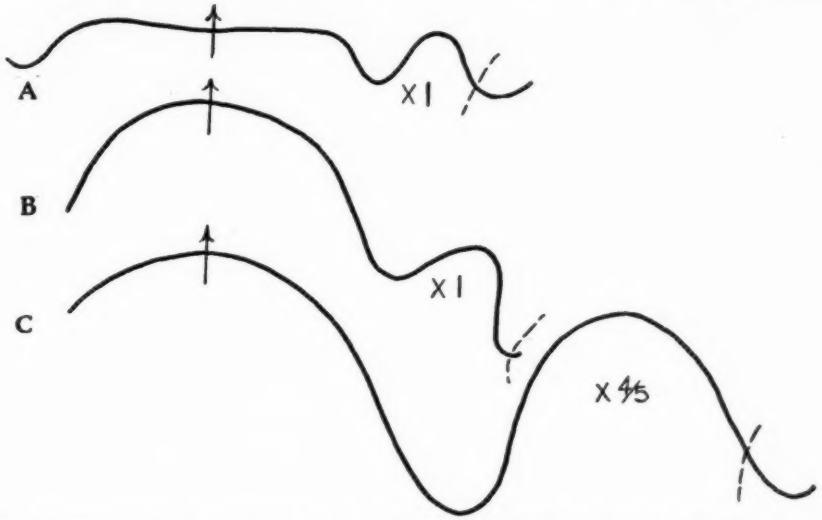


FIG. *1*—Diagrammatic representation of sutures. *A. Hercoglossa simiensis* Vokes, n. sp., holotype, ×1. *B, C, Hercoglossa merriami* Dickerson, immature holotype, ×1, and adult hypotype, ×4/5.

EUTREPHOCERAS? HALLIDAYI (Waring)

Nautilus hallidayi WARING, *1914*, Jour. Geol., vol. 22, pp. 783–784.—WARING, *1917*, California Acad. Sci., Proc., 4th. ser., vol. 7, p. 89, pl. 13, fig. 13.—NELSON, *1925*, Univ. California Publ., Dept. Geol. Sci., Bull., vol. 15, p. 403.

This species was described in both the Journal of Geology and the Proceedings of the California Academy of Sciences. The latter description was accompanied by a figure of a specimen which measures 123 mm. from the adoral end of the venter across the umbilicus to the opposite side of the conch. The figure is

said to be "$\times\frac{1}{4}$," indicating a specimen in which the greatest diameter is approximately 50 cm. rather than the 36 mm. indicated in the description. This would agree with the descriptive statement in the *Journal of Geology* that the shell is "immense." In the figure ink lines have been drawn along the weathered lines of the sutures, giving a very irregular pattern which is not diagnostic. The statement "sutures slightly inflected" agrees with the condition suggested by the last suture and makes the reference of this species to the genus *Eutrephoceras* most satisfactory.

E.? hallidayi is more discoidal in outline and not as globose as the other California species.

The type was collected from the Martinez formation, Simi Hills, Ventura County, California.

EUTREPHOCERAS HANNAI Vokes, n. sp.
Plate 2, figures 10, 11

Holotype: Univ. California Mus. Paleont. 32296, Rose Canyon shales, La Jolla formation, San Diego County, California.

Dimensions:

Diameter from adoral end of venter across the umbilicus	54 mm.
Diameter across the umbilicus at right angles to above	41 mm.
Adoral end:	
Maximum height of conch	34 mm.
Maximum width of conch	43 mm.
Height of conch to base of impressed area	23 mm.
Diameter of umbilicus	16 mm.
Adapical end:	
Maximum height of conch	13 mm.
Maximum width of conch	21 mm.

Conch moderately large, subglobular in shape and nautiliconic in its mode of growth; whorls reniform in cross section, broadly rounded ventrally and laterally, and moderately impressed dorsally; umbilicus small and deep, umbilical shoulders broadly rounded, walls steep; surface of shell smooth, marked only by fine lines of growth which indicate a broadly rounded, shallow hyponomic sinus; camerae moderately short, the last four on the adoral portion of the volution averaging 10 mm. in length; sutures straight with a low, broad saddle on the umbilical shoulder; siphuncle not seen.

Remarks.—*E. hannai* differs from *E. stephensoni* (Dickerson) in its larger size, more globose conch, and its straight sutures lacking any trace of a ventral lobe. It is smaller than *E. jonesi* Miller and Thompson and appears to be more regularly rounded on the venter and the flanks.

EXPLANATION OF PLATE 2

FIGS. *1, 3*—*Harpa* (*Eocithara*) *mutica* Lamarck, ×2; Collection of Mr. Arthur Wrigley, London, England; Lutetian, Paris Basin, France. (p. 10)

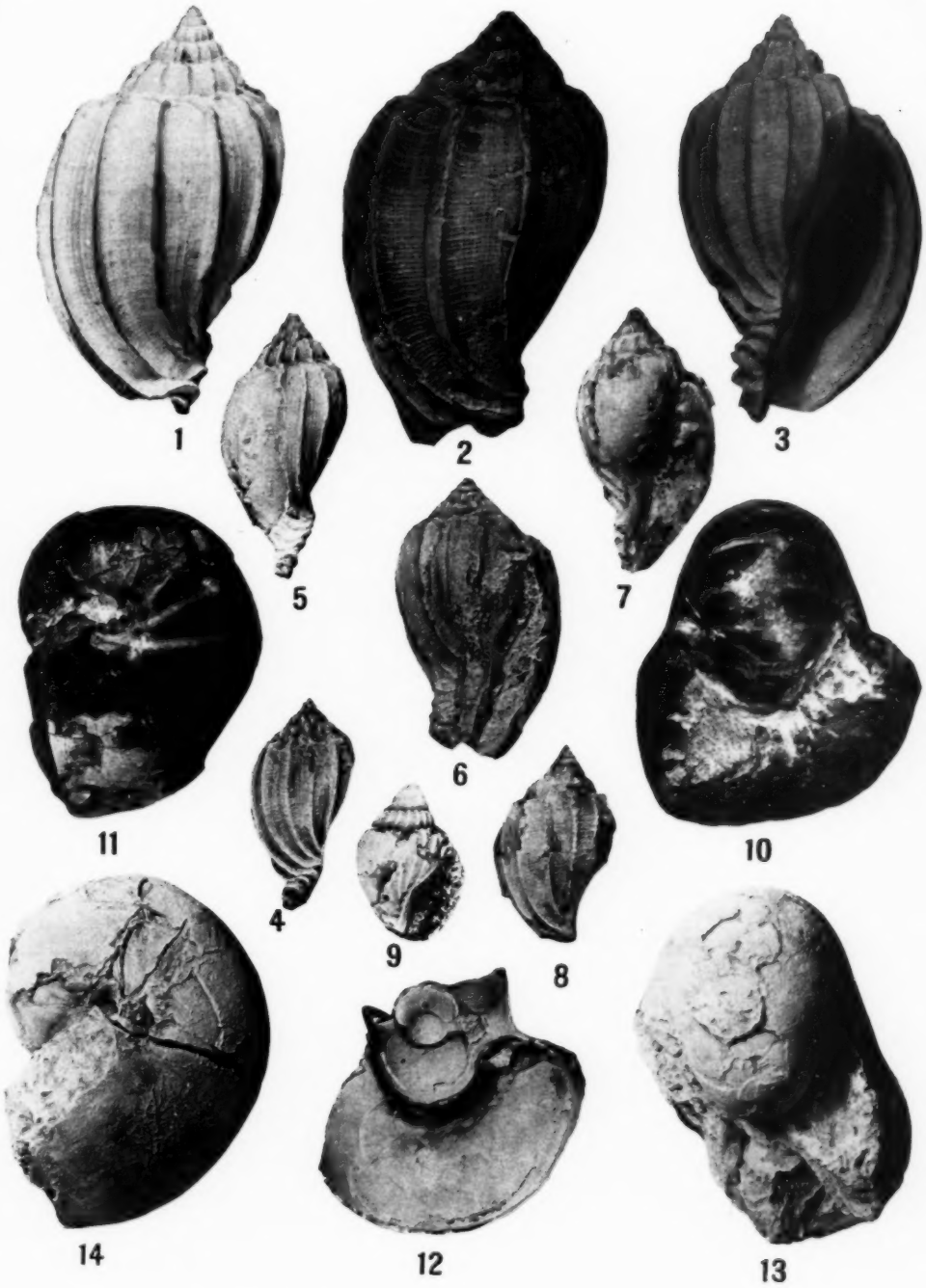
2,4,6,8—*Harpa* (*Eocithara*) *mutica* Lamarck subsp. *californiensis* Vokes, n. subsp., Llajas formation, Aliso Canyon, Ventura County, California. *2, 6*, Holotype, Univ. California Mus. Paleont. 30438; *2*, ×2.4; *6*, ×1.5. *4*, Paratype U.C.M.P. 30439, ×1.5. *8*, Paratype, U.C.M.P. 30440, ×1.5. (p. 11)

5, 7—*Harpa* (*Eocithara*) *clarki* Vokes, n. sp., holotype, U.C.M.P. 15792, ×1.5; Domengine formation, Big Tar Canyon, south of Coalinga, Kings County, California. (p. 11)

9—*Harpa? crescentensis* Weaver and Palmer, topotype, U.C.M.P. 30437, ×2.5; Port Crescent, Olympic Peninsula, Washington. (p. 12)

10, 11—*Eutrephoceras hannai* Vokes, n. sp., lateral and ventral views, ×1, of holotype, U.C.M.P. 32296; Rose Canyon shales, La Jolla formation, middle Eocene, San Diego County, California. (p. 6)

12–14—*Eutrephoceras stephensoni* (Dickerson), hypotypes, ×1.5, Martinez stage, Simi Valley, Ventura County, California. *12*, Septal view showing shape of volutions and position of siphuncle, U.C.M.P. 15893; *13, 14*, lateral and ventral views, U.C.M.P. 15982. (p. 4)



Vokes, Eocene Gastropods and Cephalopods

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E. hannai occurs in the Rose Canyon shale member of the La Jolla formation of San Diego County, California. Present information indicates that the Rose Canyon shale contains strata which are in part equivalent to the Domengine stage and in part younger. It is probably to be correlated with the upper Lutetian or the lower Auversian stage of the European sequence.

This species is named in honor of Dr. Marcus A. Hanna, of Houston, Texas, who as a graduate student at the University of California defined the La Jolla formation and its members, and described its faunas (14).

Genus HERCOGLOSSA Conrad, 1866

Genotype species, by subsequent designation (Hyatt, 1883), *Nautilus orbiculatus* Tuomey; Midway group, basal Eocene, Alabama.

HERCOGLOSSA MERRIAMI Dickerson
Plate 1, figures 1, 2

Hercoglossa merriami DICKERSON, *1914*, Univ. California Publ., Dept. Geol. Sci., Bull., vol. 8, no. 6, p. 150, pl. 17, figs. 5*a*, 5*b*.—NELSON, *1925*, idem, vol. 15, checklist.—MILLER and THOMPSON, *1933*, Jour. Paleontology, vol. 7, no. 3, p. 314.

Types: Holotype, Univ. California Mus. Paleont. 11842; loc. 243, $1\frac{3}{4}$ miles due south of Muir Station, Concord quadrangle, California. Hypotype, U.C.-M.P. 15984; loc. 3763, Simi Hills, Calabasas quadrangle, Ventura County, California. Martinez stage, "Paleocene."

Dimensions	*11842*	*15984*
Diameter from adoral end of venter across the umbilicus	95 mm.	170 ± mm.
Diameter across the umbilicus at right angles to last	68+	—
Diameter of volution at right angles to diameter at adoral end	—	92
Adoral end:		
Maximum height of conch	60	125
Maximum width of conch	60	109+
Height from preceding volution to venter	40	—
Diameter of umbilicus	17	65
Adapical end:		
Maximum height of conch	21	44+
Maximum width of conch	20	50+

The holotype of this species, an immature individual, underwent so much reconstruction before Dickerson figured it as to obscure almost all diagnostic features. Fortunately a single suture is sufficiently well preserved to permit examination of details (text-fig. 1*b*). The suture of this species is very sinuous, particularly on the adult specimen, hypotype 15984 (text-fig. 1*c*). It forms a broad, deep, broadly rounded ventral saddle; a deep, moderately narrow, asymmetrical, sharply rounded lateral lobe centering near the mid-height of the conch; and a wide, essentially symmetrical and broadly rounded lateral saddle. This description is based upon the last complete suture observable on the specimen figured. Adapically from this the suture develops the characters observable on the less mature holotype; the lateral lobe becomes essentially symmetrical and somewhat shallower; and the lateral saddle narrower and asymmetrical, with the steeper slope on the umbilical side.

The conch is nautiliconic in growth, the whorls are subglobose in outline (impressed area disregarded); the umbilical shoulders are not sharply developed and the umbilical walls slope gradually to the broad, imperforate umbilicus. The camerae are moderately long, though the last one on hypotype 15984 is only slightly more than one-half the length of the preceding. Siphuncle small and circular in section, located near the center of the septum.

This species appears to be unique in the extreme depth and narrowness of the

lateral lobes of the suture. It is most closely approached among the described North American species by *H. orbiculata* (Tuomey) (15). *H. tuomeyi* Clark and Martin (16) and *H. ulrichi* (White) (17), with which Dickerson compared it, have markedly shallower lateral lobes and correspondingly shallower and more broadly rounded lateral saddles.

HERCOGLOSSA SIMIENSIS Vokes, n. sp.
Plate 1, figures 3, 4

Holotype: Univ. California Mus. Paleont. 15985; loc. 7016, Simi Valley, Santa Susana quadrangle, Ventura County, California; Martinez stage, "Paleocene."

Dimensions:

Diameter from adoral end of venter across the umbilicus	65 mm.
Diameter *of volution* across the umbilicus at right angles to above	35 mm.
Adoral end:	
Maximum height of conch	37 mm.
Maximum width of conch	50 mm.
Height from base of impressed area to venter	28 mm.
Diameter of umbilicus (approximate)	30 mm.

The holotype, and only specimen, consists of slightly less than one-half a volution and represents six entire camerae and portions of two others, the adoral portion excellently preserved, the adapical part somewhat crushed.

Conch smooth, relatively small, subglobular, nautiliconic in mode of growth; whorls wider than high, broadly and evenly rounded ventrally and laterally, more sharply rounded dorso-laterally; moderately impressed dorsally, the impressed area being 19 mm. wide and 15 mm. deep; umbilicus apparently small, umbilical shoulder rounded, walls steep; camerae relatively short, subequally spaced; sutures forming a very broad, shallow, ventral lobe, a low ventro-lateral saddle, a broad, bluntly rounded, U-shaped lateral lobe; a similar but more broadly rounded lateral saddle and a more sharply rounded, narrower lobe on the umbilical wall (text-fig. 1*a*). Siphuncle not visible.

Remarks.—This species is distinguished by the great width of the conch in proportion to its height; the lateral lobes of the suture are so broad and shallow as to be suggestive of the genus *Cimomia* Conrad (18). It seems to be somewhat intermediate between *C. marylandensis* Miller and Thompson (1*b*) and *C. vaughani* (Gardner) (19) on one hand, and *Hercoglossa mcglameryae* Miller and Thompson (1*c*) on the other. The nature of the lateral lobes and saddles, however, makes the reference to *Hercoglossa* seem most satisfactory.

GENUS ATUROIDEA Vredenburg, 1925

Genotype species, by subsequent designation (Miller and Thompson, 1935), *Nautilus parkinsoni* Edwards; Eocene, London clay, England.

ATUROIDEA MATHEWSONII (Gabb)

Aturia mathewsonii GABB, *1864*, Paleontology California, vol. 1, pp. 59–60, pl. 17, fig. 31.

Aturoidea mathewsoni (Gabb), MILLER and THOMPSON, *1935*, Jour. Paleontology, vol. 9, pp. 569–570.

Not *Aturia mathewsonii* Gabb, DICKERSON, *1914*, Univ. California Publ., Dept. Geol. Sci., Bull., vol. 8, p. 152, pl. 18, fig. 1. [=*Aturia dickersoni* SCHENCK, *1931*, idem, vol. 19, p. 451, pl. 66, fig. 3, text-figs. 4–18; from Upper Cretaceous at Martinez, California, *fide* Schenck.]

Schenck (3*a*) has discussed the problems involved in the determination of the geologic horizon from which Gabb secured his *A. mathewsonii* and has redescribed and figured the lectotype (Univ. California Mus. Paleont. 31893).

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THE GASTROPOD GENUS *HARPA* IN THE EOCENE OF THE WESTERN UNITED STATES

H. E. VOKES
University of California, Berkeley, California

ABSTRACT

A new subspecies of *Harpa* (*Eocithara*) *mutica* Lamarck supports other evidence for correlation of the Domengine stage of California with the Lutetian of France. A second species from the Domengine stage is new. A third species, from Washington, is doubtfully retained in *Harpa*.

Among the species that suggest a correlation of the Domengine stage of the California Eocene sequence with the Lutetian stage of the Paris Basin are forms belonging to the genus *Harpa* (*Eocithara*). Two species are here reported from California, one of which is considered to be a subspecies of *H.* (*E.*) *mutica* Lamarck, of the Paris Basin. The close relationship of these forms adds confirmatory evidence to that furnished by the presence in both areas of *Velates perversus* (Gmelin) (1).

The writer wishes to express his gratitude to Mr. Arthur Wrigley, of London, England, for the loan of comparative material and for notes on additional specimens in the British Museum of Natural History.

SYSTEMATIC DESCRIPTIONS

Family HARPIDAE Troschel

Genus HARPA (Bolten) Roeding, 1798

Genotype species (by tautonomy), *Buccinum harpa* Linnaeus; Recent, Mauritius.

The generic name *Harpa*, apparently first used in a binomial sense by Rumphius in 1705, was proposed in post-Linnaean nomenclature almost simultaneously in the *Museum Boltenianum* in 1798, and by Lamarck in the *Prodrome* in 1799. The latter use is the one that is most commonly cited in the literature, the type, by monotypy, being *H. ventricosa* Lamarck. Reeve (2) considered *Buccinum harpa* Linnaeus to be a synonym of *H. ventricosa* Lamarck, but used the latter name to avoid the lack of euphony in the strict tautonomy involved.

Sugenus EOCITHARA Fischer, 1883

Genotype species (by monotypy), *Harpa mutica* Lamarck; Eocene, Lutetian stage, Paris Basin, France.

The species referrable to *Eocithara* were separated from *Harpa*, s.s., by Fischer "par le callosité de leur bord columellaire saillante et relevée" (3).

HARPA (EOCITHARA) MUTICA Lamarck

Plate 2, figures 1, 3

Harpa mutica LAMARCK, *1803*, Mus. Hist. Nat., Ann., vol. 2, p. 167.

Figured specimen: Collection of Mr. Arthur Wrigley, London, England.

Dimensions: Length, 27.2 mm.; diameter. 16.5 mm.

Mr. Wrigley, who loaned the writer the specimen figured, has kindly examined several specimens in the collections of the British Museum of Natural History

and states that the number of axial ribs varies from 15 to 16 on the first post-nuclear whorl, and is reduced to 12 to 14 on the ultimate whorl. The spiral sculpturing consists of alternating broad and finer threads, irregularly spaced. Examination of the specimen figured shows that the shoulder of the whorl tends to be devoid of spiral sculpturing, and that the number of secondary axial riblets in the interspaces between the lamellae ranges from 4 and 6.

In the Paris Basin *H. mutica* appears to be confined to, and diagnostic of, the Lutetian stage.

HARPA (EOCITHARA) MUTICA Lamarck, subsp. CALIFORNIENSIS Vokes, n. subsp.
Plate 2, figures, 2, 4, 6, 8

Types: Holotype, Univ. California Mus. Paleont. 30438; paratypes, U.C. M.P. 30439, 30440; loc. 3296, Llajas formation. Aliso Canyon, Ventura County, California.

Dimensions: Holotype, length, 26.4 mm., diameter (crushed), 16.2 mm.; paratype 30439, length, 19.8 mm., diameter (crushed), 9.7 mm.; paratype 30440, length (incomplete), 18.2 mm., diameter, 11.2 mm.

Shell of moderate size, subfusiform, globose; nucleus smooth, papillate, of approximately three whorls; post-nuclear whorls five, convex shouldered, with somewhat appressed sutures, ornamentation consisting of prominent, distant, lamellar axial ribs decreasing in number from 15 to 17 on the first post-nuclear whorl to 10 to 12 on the body whorl; interspaces ornamented with numerous (6 to 15) secondary axial riblets; spiral sculpture of numerous, irregularly spaced primary and secondary riblets, the secondary ribbing tending to extend up on the shoulder of the whorl; aperture more than twice the length of the spire, moderately narrow; outer lip simple, inner lip with a well-developed characteristic callus wash, anterior canal short; base of shell concave, with a well-developed fasciole.

Discussion.—H. mutica californiensis differs from the typical form in possessing fewer axial lamellar ribs on the body whorl. A count of the number of such ribs on several of the most satisfactorily preserved specimens in the collections, as compared to the European species, is indicated in the following table.

Number of lamellar axial ribs per whorl

	A	*B*	*C*	*D*	*E*	*F*	*G*
1st post-nuclear whorl.	17	15	17	17	—	—	16
3rd post-nuclear whorl.	15	13	15	15	17	14	15
Penultimate whorl.....	13	12	14	13	15	14	14
Ultimate whorl	11	11	12	10	11	12	13

A. Holotype
B. Paratype 30439
C. Paratype 30440
D, E, F. Paratypes
G. Figured European specimen

The generally larger number of secondary axial riblets, and the tendency for the secondary spirals to appear on the shoulder of the whorl will also serve to distinguish the California subspecies from the typical *H. mutica*. The relationship between the two is very close and strongly suggests that the deposits in the two areas in which they occur are of approximately contemporaneous deposition.

Dr. Bruce L. Clark, of the University of California, was the first to note this relationship and to suggest the probable contemporaneity of the strata involved. During 1932 and 1933 he compared specimens of the California form with European material, and deposited examples of the new subspecies in the collections of the British Museum.

HARPA (EOCITHARA) CLARKI Vokes, n. sp.
Plate 2, figures 5, 7

Holotype: Univ. California Mus. Paleont. 15792; loc. A-1165, Big Tar Canyon, south of Coalinga, California; Domengine formation.

Dimensions: Length, 26.4 mm.; diameter, 14.6 mm.

Shell of moderate size, thin, subfusiform; spire high, of five post-nuclear

whorls, ornamented with slightly sinuous, lamellar axial ribs separated by broad interspaces; interspaces marked by five narrow, secondary axial threads and numerous spiral ribs of equal strength, separated by interspaces about twice the width of the spiral; with 13 axial lamellae on the third post-nuclear whorl, 14 on the penultimate, and 16 on the ultimate whorl; whorls shouldered but slightly, sutured appressed, distinct; aperture twice the length of the spire, narrow; outer lip simple, inner lip with a characteristic callus wash; base of the shell concave, recurved to a strong fasciole ornamented with the axial lamellae.

Discussion.—*H. clarki* differs from the species of the *H. mutica* group primarily in possessing more axial lamellae on the body whorl than on the spire whorls, rather than having a lesser number on the ultimate whorl. The spire tends to be more elevated, and the whorls not as strongly shouldered, whereas the number of secondary axial ribs remains more constant in the interspaces between the lamellae. The absence of any secondary spiral sculpturing is also distinctive.

This species is known only from the Reef Ridge section of the Domengine formation, south of Coalinga, California.

HARPA? CRESCENTENSIS
Weaver and Palmer
Plate 2, figure 9

Harpa crescentensis WEAVER and PALMER, *1922*, Univ. Washington, Publ. Geol., vol. 1, no. 3, p. 40, pl. 11, fig. 21.

Topotype: Univ. California Mus. Paleont. 30437; Observation Point, Port Crescent, Olympic Peninsula, Washington.

Dimensions: Length (crushed), 9.3 mm.; diameter, 6.6 mm.

Remarks.—The smaller size and a somewhat more broadly conical nucleus than is characteristic of the type species of *Harpa* make the reference of this form to *Harpa* (*Eocithara*) somewhat questionable, but in the absence of adequate material it is provisionally retained in this genus. The only specimen available for study is a somewhat poorly preserved individual lacking most of the shell on the penultimate and ultimate whorls. There are about 21 axial ribs on the first post-nuclear whorl. There is no evidence as to the presence of secondary axial riblets in the interspaces between the lamellae.

The strata at Port Crescent, on the Olympic Peninsula of Washington, in which this species occurs, appear to be a correlative of the Domengine formation of California. Recent collections by a field party from the University of California Museum of Paleontology include the following species known to occur in the fauna of the type Domengine near Coalinga, California:

Ficopsis remondii (Gabb) subsp. *crescentensis* Weaver and Palmer, *Cernina* (*Eocernina*) *hannibali* (Dickerson), *Crommium andersoni* (Dickerson), *Keilostoma* n. sp., *Loxotrema turrita* Gabb, *Neverita globosa* Gabb, "*Pachycrommium*" *clarki* (Stewart), *Turritella uvasana* Conrad, n. subsp.

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PLICATODERBYA, A NEW PERMIAN BRACHIOPOD SUBGENUS

HORACE D. THOMAS
University of Wyoming, Laramie, Wyo.

ABSTRACT

Permian brachiopods, with the contour and internal structure of *Derbya* but with prominently plicated shells, are included in a new subgenus, *Plicatoderbya*. The characters of the subgenus are outlined and the genoholotype, a previously described species, is re-described and figured. Two species, one from Wyoming and one from the Salt Range, India, are contained in the subgenus.

The Ervay tongue of the Phosphoria formation (1) in the Rattlesnake Hills, Natrona County, Wyoming, contains innumerable specimens of a large brachiopod which is internally similar to *Derbya*, but which differs from typical members of the genus in that the valves are conspicuously plicated. In attempting to identify the Rattlesnake Hills specimens with *Meekella rotunda* or with *Orthotetes magnus*, both described by C. C. Branson (2) from the upper part of the Phosphoria of the Wind River and Owl Creek Mountains, difficulties presented themselves which could not be satisfied until the type specimens of those species were studied. The types were subsequently loaned by E. B. Branson to C. O. Dunbar, who studied their morphology and compared them with the Rattlesnake Hills specimens.

It is here appropriate to express thanks to Doctor Dunbar for his generous aid. The writer has drawn freely upon his diagnoses of the type specimens and of the Rattlesnake Hills specimens. Thanks are also extended to E. B. Branson for the loan of the type specimens, and to R. C. Moore for the loan of specimens collected in the vicinity of Cody, Wyoming.

The study is based on about a hundred specimens from the Ervay tongue in the Rattlesnake Hills; about thirty specimens from the upper part of the Phosphoria at Bull Lake, in the Wind River Mountains; and a dozen specimens from a similar horizon from near Anchor, in the Owl Creek Mountains. Few specimens are completely preserved. Those from the Phosphoria at Bull Lake are all internal molds, a few of which retain patches of the original shell. The Rattlesnake Hills specimens are mainly internal molds composed of red chert, but a good many retain portions of the silicified shell. Among the Rattlesnake Hills specimens juvenile shells are much the best preserved, larger specimens being generally crushed or broken. Those from the Owl Creek Mountains are the best preserved and have most of the shell present.

The age of the upper part of the Phosphoria, on the basis of the interpretations of the brachiopods (3) and the cephalopods (4) now seems to be quite definitely established as Middle Permian. The Ervay tongue of the Phosphoria is also of this age.

SYSTEMATIC DESCRIPTIONS

Family STROPHOMENIDAE
Subfamily ORTHOTETINAE
Genus DERBYA Waagen
Subgenus PLICATODERBYA
Thomas, n. subgen.

Genoholotype: *Derbya* (*Plicatoderbya*) *magna* (Branson)—*Orthotetes magnus* Branson, 1930.

Diagnosis: Shells similar to *Derbya* but bearing rounded radial plications.

Discussion.—The Orthotetinae are divided into genera on the basis of internal structure and external sculpture. Plicate and non-plicate forms with similar internal structure constitute distinct genera, such as plicate *Meekella* and non-plicate *Orthotetina*, or plicate *Kiangsiella* and non-plicate *Streptorhynchus* (5.)

The philosophical question as to whether the presence of plications constitutes a valid criterion for the differentiation of genera need not be discussed. Grabau believed it to be such when he erected the genus *Kiangsiella*. Girty has said, however, that he believes "each structural type [of the Orthotetinae] can appropriately be esteemed of generic rank with plicated varieties distinguished as subgenera" (6). *Plicatoderbya* is here proposed as a subgeneric name. Its usefulness is the same, no matter to what rank it is assigned.

DERBYA (PLICATODERBYA) MAGNA
(Branson), emend. Thomas

Plate 3, figures 1–8

Orthotetes magnus BRANSON, *1930*, Univ. Missouri Stud., vol. 5, no. 2, pp. 26–27, pl. 4, figs. 1–5.

Meekella rotunda BRANSON, *1930*, Univ. Missouri Stud., vol. 5, no. 2, pp. 28–29, pl. 5, figs. 1–6; pl. 7, figs. 1–5.

Not *Derbya magna* LICHAREW, *1932*, United Geol. Prosp. Serv. U.S.S.R., Trans., fasc. 215, p. 18 (in Russian), p. 40 (in English), pl. 1, figs. 1, 2, 6, 7; pl. 2, fig. 1; pl. 3, fig. 1. (7).

External features: Shell biconvex, commonly distorted; hinge line as long or nearly as long as the greatest width of the shell; length and width about equal in ordinary specimens. Dorsal valve moderately convex, the degree of convexity varying with the individual; umbo slightly inflated and moderately prominent; the point of greatest height within the posterior half of the valve and most often near the beak; some specimens with a regular curvature, but the valve usually rising rapidly from the beak and flattening toward the anterior margin; the posterolateral margins transversely depressed and flattened; beak moderately prominent, projecting slightly beyond the hinge line; dorsal cardinal area absent. Ventral valve subpyramidal, with a high, elevated beak, usually quite distorted and variable in its prominence; in some specimens the entire valve distorted; in undistorted specimens valve but gently convex, showing a regular curve from the beak to the anterior margin; point of greatest height at the beak; in many specimens, owing to distortion, the valve markedly asymmetric.

The flat or only slightly concave cardinal area extremely diverse in height compared to the size of the shell, the ratio of width of hinge line to height of the cardinal area ranging from 3 to 1 to $1\frac{1}{2}$ to 1; a ratio of about 2 to 1 apparently most usual. A proportionately higher cardinal area apparently characteristic of juvenile shells, in the smallest individual in the collection the hinge being 15 mm. wide, the cardinal area 10 mm. high; in mature shells the ratio increasing so that shells with hinge line 40 mm. long have a cardinal area 15 mm. high; in gerontic individuals the cardinal area proportionately lower. Two individuals of equal size seldom possess an area of the same height or shape, the diversity probably being related to the distortion of the beaks. No specimen available with perfectly preserved deltidium or perideltidial area, it being apparent only that the deltidium is relatively narrow and differs considerably in

height in different specimens along with the diversity in height of the cardinal area; a triangular, vertically striated perideltidial area present, slightly raised above the level of the cardinal area; angle formed by the cardinal area and the plane of the valves ranging from 30° to 80°, although most commonly between 45° and 60°.

Surface ornamentation unique, here considered to be of subgeneric importance. Sculpture of irregular rounded to sub-angular radial plicae; irregular concentric rugae; and fine, regular, radial lirae and striae superimposed on the other two types of sculpture; each specimen with individual diversity in the degree of development of the first two types. Starting some distance in front of the beaks and extending to the anterior margins of the valves occur irregular radial plicae which become most conspicuous near the margin of the shell; adjacent plicae rarely of equal strength, on many specimens almost obsolete; interspaces, or sulci, seldom of equal width, because of the irregularity in spacing of the plicae; on the dorsal valve the plicae starting in front of the umbo, which is not plicated; plicae usually more prominent on the ventral valve, on some specimens beginning nearer the beak than on the dorsal valve; plications on small specimens apparently more regular than those on large ones, on which the plicae are conspicuously irregular or wavy. Rugae not as conspicuous as the radial plicae, on many specimens obsolete; when present, the rugae differ in strength and range in number from 1 to 6. With both rugae and radial plicae well-developed knobs or bosses at the intersections of rugae and plicae, depressions at the intersections of radial sulci and concentric sulci; such ornamentation generally on large specimens only, although many smaller shells show numerous obscure pits and knobs; both types of sculpture visible on internal molds, but never so strikingly shown as on specimens which retain the shell. Superimposed on the coarser sculpture fine lirae and striae, as in *Derbya;* lirae quite straight, on the major portion of the shell extending across the intersecting radial plicae and concentric rugae with but little deviation; on the flattened postero-lateral margins lirae starting at the beak and curving laterally to meet the margins of the shell at right angles; lirae rounded, about 30 in the space of a centimeter; of normal size near the beak, increasing in number by bifurcation; intervening striae rounded, ranging in size from the same width as the lirae to only half that size; lirae and striae apparent on internal molds but not as conspicuous as on shells. Occasionally directions of plicae and lirae do not coincide, owing to the curvature of the plicae; on such examples the lirae continue in a straight line and cut obliquely over the plicae.

Internal structure: Internal structures not well shown, for no specimen presents the hollow interior of a valve; structures discernible on internal molds, however, well displayed. In the dorsal valve two well developed crural lamellae projecting forward from the beak, diverging at about 90°; contour of the valve directly related to the presence of these erect septum-like plates; median portion of valve, between the two lamellae, forming the area of the moderately inflated umbo; regions between the plates and cardinal extremities forming the flattened areas on the postero-lateral margins; length of the lamellae somewhat diverse, from 15 to 20 mm. in ordinary individuals; a low median ridge bisecting the angle formed by the crural lamellae, shown on internal molds as a shallow, narrow groove of about the same length as the crural plates. Most conspicuous structure of the ventral valve a well developed, high median septum, usually about half as long as the shell; dental lamellae obsolescent, being reduced to a short flange under the deltidium.

Size of specimens: Specimens from the vicinity of Bull Lake Creek, in the Wind River Mountains, and from the Rattlesnake Hills average 45 mm. in length and width. The specimens from the Owl

Creek Mountains seem to average somewhat larger in size, perhaps 60 to 70 mm. in length and width. Two specimens are about 50 mm. in length and width, in which respect they agree with Wind River Mountains specimens. The largest individual from the Owl Creek Mountains is 110 mm. wide and 70 mm. long. The smallest specimen in the collection is from the Rattlesnake Hills and is but 15 mm. in length and width. The largest specimen from the Rattlesnake Hills is 75 mm. long and, although incomplete, was apparently about 80 mm. wide.

Occurrence.—Near top of the Phosphoria formation of the Wind River Mountains and the Owl Creek Mountains; and upper "Embar" (probably a correlative of the Ervay tongue) west of Cody, Wyoming; in the Ervay tongue of the Phosphoria in the Rattlesnake Hills, and on the west fork of Cottonwood Creek, Green Mountains, Wyoming.

Discussion.—Two species, *"Orthotetes" magnus* and *"Meekella" rotunda*, were based on sets of individuals which appear quite unlike. The types of *"Orthotetes" magnus* were collected in the Owl Creek Mountains and those of *"Meekella" rotunda* in the Wind River Mountains. From evidence now shown by specimens from the Rattlesnake Hills, it is believed that the two are but variants of one highly variable species. Because of page precedence, the name of the species becomes *Derbya* (*Plicatoderbya*) *magna* (Branson), and *"Meekella" rotunda* is placed in its synonymy.

Long dental lamellae, which characterize *Meekella*, are not present in the types of *"Meekella" rotunda* as described by Branson. One shows clearly that the dental plates are obsolete, and that a well developed median septum is present in the ventral valve. Divergent crural lamellae are present in the dorsal valve. The specimens are exfoliated, but show evidence of numerous, rather faint plications that number about 14 at the anterior margin, but that cannot be identified upon the umbones, which were probably smooth. The type specimens average 45 mm. in length and width and are considerably smaller than Branson's illustrations.

The holotype of *"Orthotetes" magnus* is a large specimen from which the beak and cardinal area of the ventral valve have weathered away. The dorsal valve is broken along one of the crural lamellae, which is very high and extends far into the valve. The nearly flat surface of this lamella was apparently taken by Branson to be the cardinal area, for the dorsal valve was illustrated as a ventral valve (*2a*). The characters of the species as outlined by Branson are therefore subject to the alterations which have been

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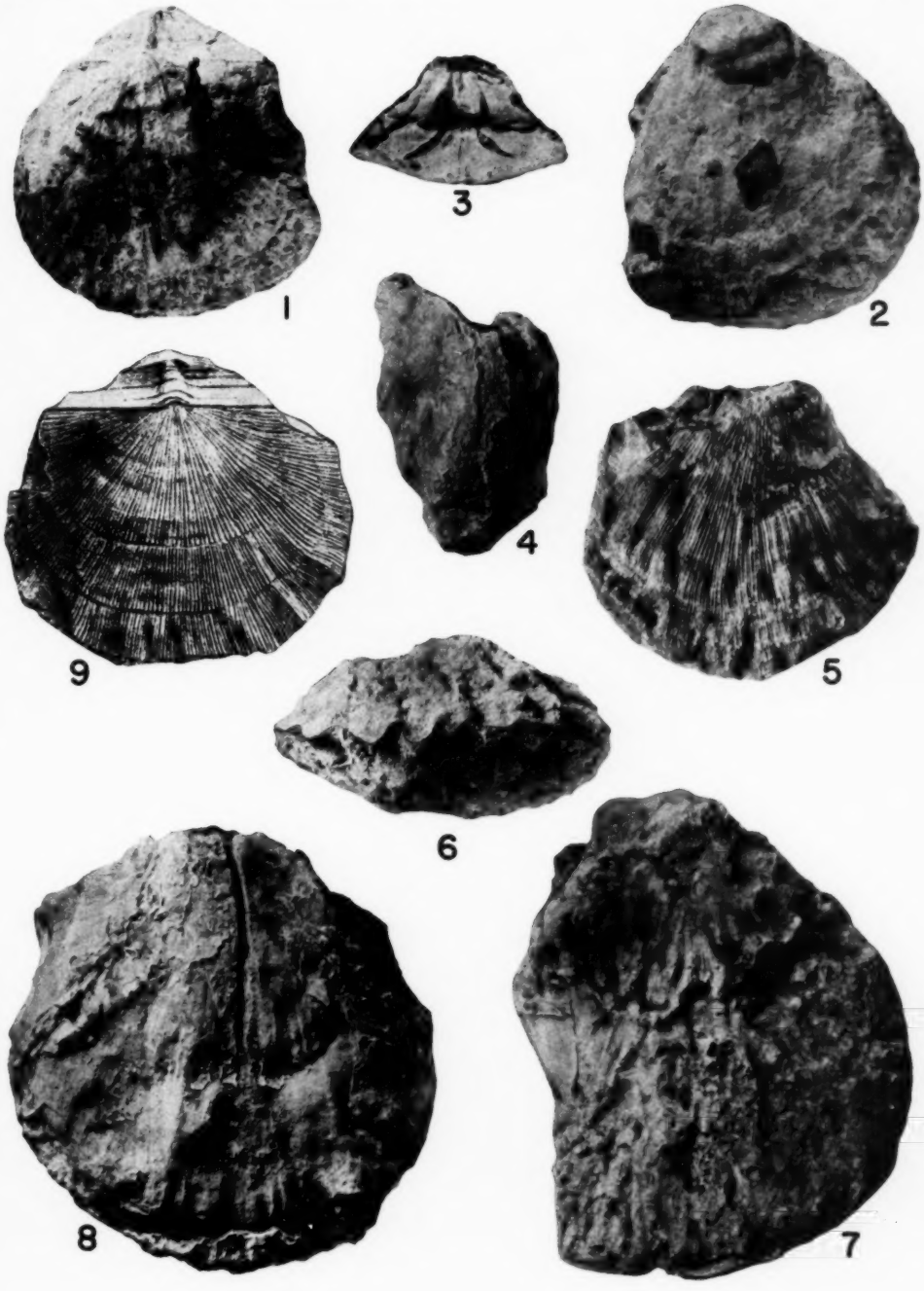
EXPLANATION OF PLATE 3

FIGS. *1–8*—*Derbya* (*Plicatoderbya*) *magna* (Branson), n. subgen., all natural size. *1, 2*, Dorsal and ventral views of a syntype of *"Meekella" rotunda*, from the upper Phosphoria on Bull Lake Creek, Wind River Mountains, Wyoming. This specimen shown by Branson as his pl. 5, figs. 3, 6. *3*, Posterior view of a small internal mold with conspicuous crural plates, from the Ervay tongue of the Phosphoria, Rattlesnake Hills, Wyoming. The tip of the beak is broken off. *4*, Lateral view of a partly exfoliated specimen from the Ervay tongue, Rattlesnake Hills. *5*, Ventral view of a specimen from the Ervay tongue, Rattlesnake Hills. This individual is about the size of the types of *"Meekella" rotunda* but shows prominent plicae and rugae, as on the types of *"Orthotetes" magnus*. *6*, Anterior view of a prominently plicated specimen from the Ervay tongue, Rattlesnake Hills. *7*, Ventral view of a large, crushed, incomplete specimen from the Ervay tongue, Rattlesnake Hills. *8*, Ventral view of exfoliated specimen with a prominent median septum, from the Phosphoria formation, Owl Creek Mountains, Wyoming. This individual approaches the holotype of *"Orthotetes" magnus* in size and in ornamentation, and comes from the same horizon and locality as the holotype. (p. 14)

9—*Derbya* (*Plicatoderbya*) *plicatella* (Waagen). Reproduction of Waagen's protograph of the species. (p. 17)



Thomas, Permian Brachiopods

UNIV. OF MICH.

included in the foregoing description. The ornamentation comprises irregular wavy plications and superimposed lirae. The internal structures of a paratype are identical with those described above for the types of "*Meekella*" *rotunda*.

Specimens from the Rattlesnake Hills show an unusual degree of individual variation. All of the specimens agree with "*Meekella*" *rotunda* and "*Orthotetes*" *magnus* in internal structure. Some of the specimens, however, show faint regular plications similar to those on the types of "*Meekella*" *rotunda* and larger specimens show irregular wavy plications similar to those on the types of "*Orthotetes*" *magnus*. Specimens of intermediate size have surface sculpture of an intermediate nature.

With fewer specimens at hand, the writer would have been tempted to split the shells into a number of species. With numerous examples available, however, he has grouped them into one extremely variable species, because the specimens grade in size from small to large and the nature of the ornamentation differs with the size of the individuals; and because among specimens of the same size there is much diversity in the degree of distortion, in the ratio of the height of the cardinal area to the length of the hinge line, in the angle formed by the cardinal area and the plane of the valves, and in the strength and number of the plications and their regularity or irregularity. End forms are readily distinguished, as are the types of "*Orthotetes*" *magnus* and "*Meekella*" *rotunda*, but the majority of shells have characteristics intermediate between the two forms. Smaller specimens in the writer's collection from the Owl Creek Mountains are associated directly with shells similar to the types of "*Orthotetes*" *magnus*, but if found in the Wind River Mountains would surely be identified as "*Meekella*" *rotunda*. It is possible that if still more specimens were available, it would then be practicable to divide them into distinct varieties. It seems unprofitable, however, to do so now. In view of the fact that the stratigraphic horizon of all the variants is essentially the same, there is no particular reason for splitting the species.

DERBYA (PLICATODERBYA) PLICATELLA (Waagen)

Plate 3, figure 9

Derbyia plicatella WAAGEN, *1884*, Geol. Survey India, Mem., Pal. Indica, ser. 13, vol. 1, pp. 601–602, pl. 55; (separate from text) fig. 3, 1887 (Part 4, fas. 3, containing the description of this species, was published May 1, 1884).

Ventral valve arched; beak pointed, incurved; cardinal area broad, high, strongly concave; valve internally bears a strong median septum. Dorsal valve more inflated than ventral, with regular curvature; beak inconspicuous; dorsal cardinal area narrow but distinct. Sculpture consists of concentric rugae, best developed on ventral valve, which toward the margin are replaced by irregular, low radial plications which are best developed at the margin, and which are variable in their spacing. Finer striae and lirae are superimposed on this sculpture.

Length of ventral valve, 47 mm.; dorsal valve, 40 mm.; greatest width, 52 mm.; length of hinge line, 38 mm.; thickness, 27 mm.

Occurrence.—The single specimen on which the species was based was collected near Jabi, Salt Range, India, from the Cephalopoda bed of the Upper Productus limestone [Chideru group, Upper Permian (8)].

Discussion.—It has been impossible, of course, to examine the type specimen of *D.* (*P.*) *plicatella*, and any comparisons with *D.* (*P.*) *magna* must necessarily rest upon Waagen's description and his illustration of a dorsal view of *plicatella*. There are specimens of *magna* which, if compared with Waagen's illustration, might well be considered to be specimens of *plicatella*. The two species are apparently very similar in size, shape and sculpture. It is difficult to interpret Waagen's conception of the "strongly concave" cardinal area. If the writer's conception agrees with Waagen's, then the two species differ in this respect,

for *magna* has a cardinal area which is flat or only moderately concave. However, because of their geographic occurrence in two widely separated regions, it is probable that, if specimens of the two species could be compared, striking differences might be apparent.

PHYLOGENY

Plicatoderbya evolved directly from *Derbya*, s. s., by the development of plicated shells, at much the same time as *Kiangsiella* diverged from *Streptorhynchus* and in the same manner. Since the present known range of *Plicatoderbya* is from the Middle Permian to the Upper Permian, the divergence from the *Derbya* stock possibly took place in Early Permian time.

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JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 19–23, PL. 4, JANUARY, 1937

UPPER JURASSIC AND LOWER CRETACEOUS FORAMINIFERA FROM THE MALONE MOUNTAINS, TRANS-PECOS TEXAS

CLAUDE C. ALBRITTON, JR.
Harvard University, Cambridge, Massachusetts

ABSTRACT

Seven species of foraminifera from the Malone (Jurassic) and Torcer (Cretaceous) formations of Texas are described. Four species are new; the remaining three have not been previously reported from the Malone area.

In the course of field work in the Malone Mountains, Hudspeth County, Texas, the writer made systematic collections of samples from the Upper Jurassic and Lower Cretaceous formations there exposed. The seven species described were gleaned from some sixty washed samples. The rarity of the individual occurrences enhances the intrinsic interest of this meager fauna.

It is not the writer's purpose to discuss in this paper the stratigraphic significance of these fossils. However, in view of the inaccuracy of some of the published stratigraphic sections of the Malone Mountains, it is necessary tc include the following generalized section, to which the fossils may be referred:

Section in Malone Mountains, Texas

	Thickness Feet
Lower Cretaceous.	
Las Vigas formation (?): Sandy shale, impure limestone, and limestone pebble conglomerate; over.....	50
Torcer formation (emended): Impure limestone, sandstone, and sandy shale, with persistent basal conglomerate and quartzitic sandstone; over.....	400
Upper Jurassic.	
Malone formation (emended):	
Upper division—black limestone with occasional sandy beds toward top; maximum..	350
Lower division—thin-bedded sandstone, sandy shale, impure limestone and limestone conglomerate; maximum....	575
Unconformity	
Permian.	
Briggs formation: Gypsum with interbedded limestone; over...	300

Acknowledgments.—The writer wishes to express his appreciation to his father, C. C. Albritton, Sr., for aid in collecting samples and in financing field work. The paleontological investigation was conducted under the direction of Dr. J. A. Cushman, who generously granted the writer permission to work in his laboratory at Sharon, Massachusetts. The writer is grateful to Doctor Cushman for criticism of the manuscript and for use of his collections and library. Illustrations are the work of Miss Ann Shepard of the Cushman Laboratory staff.

SYSTEMATIC DESCRIPTIONS

Family SACCAMMINIDAE Cushman
Subfamily SACCAMMININAE Cushman

Genus SACCAMMINA M. Sars.

SACCAMMINA cf. S. SPHAERICA M. Sars

Plate 4, figure 7

Saccammina sphaerica M. Sars. HAEUSLER, *1890*, Schweiz. Palaeont. Ges., Abh., vol. 17, pp. 16–17, pl. I, fig. 4.

Test free, consisting of a single, unpartitioned, spherical chamber; wall thin, composed of small, comparatively regularly-sized, clear, angular quartz grains; outside rough, inside smooth; aperture unknown. Diameter 0.42 mm.

Figured specimen: Cushman Coll. 22541; basal sandstone and conglomerate of Torcer formation, V-Canyon, Malone Mountains.

Family LITUOLIDAE Cushman
Subfamily HAPLOPHRAGMINAE Cushman

Genus AMMOBACULITES Cushman

AMMOBACULITES SUBCRETACEUS Cushman and Alexander

Plate 4, figures 3, 4

Ammobaculites subcretacea CUSHMAN and ALEXANDER, *1930*, Cushman Lab. Foram. Res., Contr., vol. 6, pl. 2, figs. 9, 10.

Test compressed; earlier portion coiled, last few chambers in rectilinear series; wall of clear, coarse, irregular quartz grains, cement gray, surface rough; aperture terminal, obscure in single specimen at hand. Length, 0.57 mm.; diameter of coiled portion, 0.35 mm.; thickness of coiled portion, 0.20 mm.

This species was first described from the Lower Cretaceous Goodland formation of Texas.

Hypotype: Cushman Coll. 22543; Torcer formation, Cedar Canyon, Malone Mountains.

Family LAGENIDAE Cushman
Subfamily NODOSARIINAE Cushman

Genus ROBULUS Montfort

ROBULUS PROMAMILLIGERUS Albritton, n. sp.

Plate 4, figures 1, 2

Test small, moderately compressed, lenticular; planispiral, completely involute; surface uneven, finely papillate with rounded bosses standing in conspicuous relief, papillae randomly arranged, exhibiting no discernible tendency toward alignment along traces of sutures; peripheral keel low, stout and rounded, with an unevenly crenulated margin; aperture obscure, at or near the peripheral angle. Diameter, 0.31 mm.; thickness at umbo, 0.18 mm.

The only species with which the Malone form is likely to be confused is "*Cristellaria mamilligera* Karrer," reported from the Upper Jurassic (Oxfordian?) of Memel (1). From the Memel form *Robulus promamilligerus* may be distinguished by the random arrangement of smaller nodes on the sides of the latter. The writer questions the advisability of referring the Memel species to *Cristellaria mamilligera* Karrer. Karrer's figures of the type show a compressed form with wide keel, and nodes closely aligned over traces of the sutures in the younger stages, succeeded by simple costae on the latter portion of the outer whorl (2). This transition from nodes to costae may be observed in Brady's figures (3) of more rotund forms assigned to *C. mamilligera* Karrer. Likewise, Cretaceous forms of this species described from New Jersey by Weller (4) are to all appearances identical with those described by Brady. In Brückmann's Memel forms, on the other hand, there is no transition from uniformly aligned nodes to costae; indeed the earlier portions of the last whorl show widely scattered nodes with little systematic arrangement. It might be

better for classificatory purposes, therefore, to remove the Memel species from *Cristellaria mamilligera* Karrer, and either assign to it a new specific name, or, under a broader taxonomic concept, place it in synonomy with *Robulus promamilligerus*.

Holotype: Cushman Coll. 24540; Malone formation, lower division, Trigonia Creek, Malone Mountains.

ROBULUS MALONIANUS Albritton, n. sp.

Plate 4, figures 5, 6

Cristellaria osnabrugensis Münster var. *münsteri* BRÜCKMANN (not Ruess), *1904*, Phys. Ges. Königsberg, Schrift., Jahrg. 45, p. 15, pl. 3, figs. 14–16.

Test small, lenticular; planispiral, completely involute, with 7 to 8 chambers in last whorl; chambers overlapping with basal margins undercut; wall finely perforate, traversed by prominent, flexuous, somewhat irregular, locally nodose costae marking traces of sutures; ribs merge centrally to form a low polygonal wall more or less completely surrounding the umbilicus; peripherally ribs join stout, low, rounded keel which is finely crenulate, owing to evenly spaced depressions; aperture at peripheral angle (?), nature (whether radiate or simply circular) unknown. Diameter of last whorl, 0.42 mm.; thickness at umbo, 0.17 mm.

This form cannot be distinguished from a form from the Upper Jurassic (Oxfordian?) of Memel referred by Brückmann to *Cristellaria osnabrugensis* var. *münsteri* Reuss. The pertinent portion of Brückmann's description is freely translated as follows:

This form is the most abundant of the sculptured Cristellarias. Like the others it shows considerable variation in degree of compression of test (some forms being elongate in cross-section, others round) and involution (some forms showing the earlier whorls, others completely involute). Yet in all instances the septa are reflected on the surface of the test by well-developed ribs similar to those of *Epistomina mosquensis*. In the umbilical area the ribs join to form an irregular polygon enclosing a flat arcuate area opening anteriorly on the surface. In some examples the polygon is broken down into a series of prominent nodes.

Reuss' variety was originally described from the Oligocene of Germany, and comparison of the two reveals that Reuss' Oligocene form may be distinguished from the Memel form by the superior height of the last whorl and more compressed test of the former (5).

Robulus malonianus, though closely related to *Cristellaria quenstedti* Gümbel, from the Upper Jurassic of Germany, may be distinguished from the latter by its more compressed whorls, less regular costae, and comparatively elevated umbilical area (6). From *Lenticulina helios* Terquem, as figured and described by Sandidge, the Malone species may be distinguished by its more inflated whorls and nodose costae, possibly in addition by fewer chambers per whorl and forward, rather than upwardly directed aperture (7).

Holotype: Cushman Coll. 22539; Malone formation, lower division, Finlay Spur, Malone Mountains.

Subfamily LAGENINAE Cushman

Genus LAGENA Walker and Jacob

LAGENA? sp.

Plate 4, figure 11

A single fragmentary test associated with *Gümbelina paucistriata* and *Anomalina torcerensis* is here referred questionably to *Lagena*. The surface of the hemispherical fragment is covered with strong costae, the disposition of which suggests a relationship to *Lagena sulcata* Walker and Jacob. This species has been reported from the Lower Cretaceous Del Rio formation of Texas (8).

Figured specimen: Cushman Coll. 22542; basal sandstone and conglomerate member of Torcer formation, V-Canyon, Malone Mountains.

Family HETEROHELICIDAE Cushman
Subfamily HETEROHELICINAE Cushman
Genus GÜMBELINA Egger

GÜMBELINA PAUCISTRIATA Albritton, n. sp.

Plate 4, figures 8–10

Test in microspheric form with earliest chambers planispirally coiled, later chambers biserial; in megalospheric form apparently biserial from beginning; chambers globose, as a rule increasing regularly in size as added; sutures depressed, distinct; wall with fine longitudinal striae discontinuous at the sutures, in some specimens the striations are obscure, in others strength of ribbing decreases with increasing size of test; aperture moderately large, a crescentic opening at the inner margin of the final chamber. Height, 0.31 mm.; breadth, 0.20 mm.; thickness, 0.11 mm.

As in other species, the large planispiral whorl occasionally exhibited in the younger stages of this species appears to be a primitive characteristic, one which is often lost in later developments of the genus. The delicate costation, large planispiral whorl of the megalospheric form, and broad low aperture serve to distinguish the species from all those encountered in the literature by the writer. The fainter, more delicate costation disguishes the Malone species from *Gümbelina striata* Ehrenberg, a related form that has been reported from the Cretaceous of Texas.

Holotype: Cushman Coll. 22537; basal sandstone and conglomerate member of Torcer formation, V-Canyon, Malone Mountains.

Family ANOMALINIDAE Cushman
Subfamily ANOMALININAE Cushman
Genus ANOMALINA D'Orbigny

ANOMALINA TORCERENSIS Albritton, n. sp.

Plate 4, figures 12–14

Test compressed, trochoid in young stages, planispiral, almost completely involute in mature stage; margin narrowly rounded; chambers numerous, 7 to 9 in last whorl, increasing very little in size as added, last few slightly inflated; sutures distinct, flexuous, slightly depressed; wall smooth, conspicuously perforate, with thickening of central area on both dorsal and ventral sides; aperture peripheral, at base of last formed chamber, extending slightly onto dorsal side. Diameter, 0.31 mm., thickness, 0.10 mm.

EXPLANATION OF PLATE 4

All figures ×70 except as indicated

FIGS. *1, 2*—*Robulus promamilligerus* Albritton, n. sp., holotype, side and front views; Jurassic Malone formation, lower division. (p. 20)

3, 4—*Ammobaculites subcretaceus* Cushman and Alexander, hypotype, side and peripheral views; Lower Cretaceous, Torcer formation. (p. 20)

5, 6—*Robulus malonianus* Albritton, n. sp., holotype, side and front views; Jurassic, Malone formation, lower division. (p. 21)

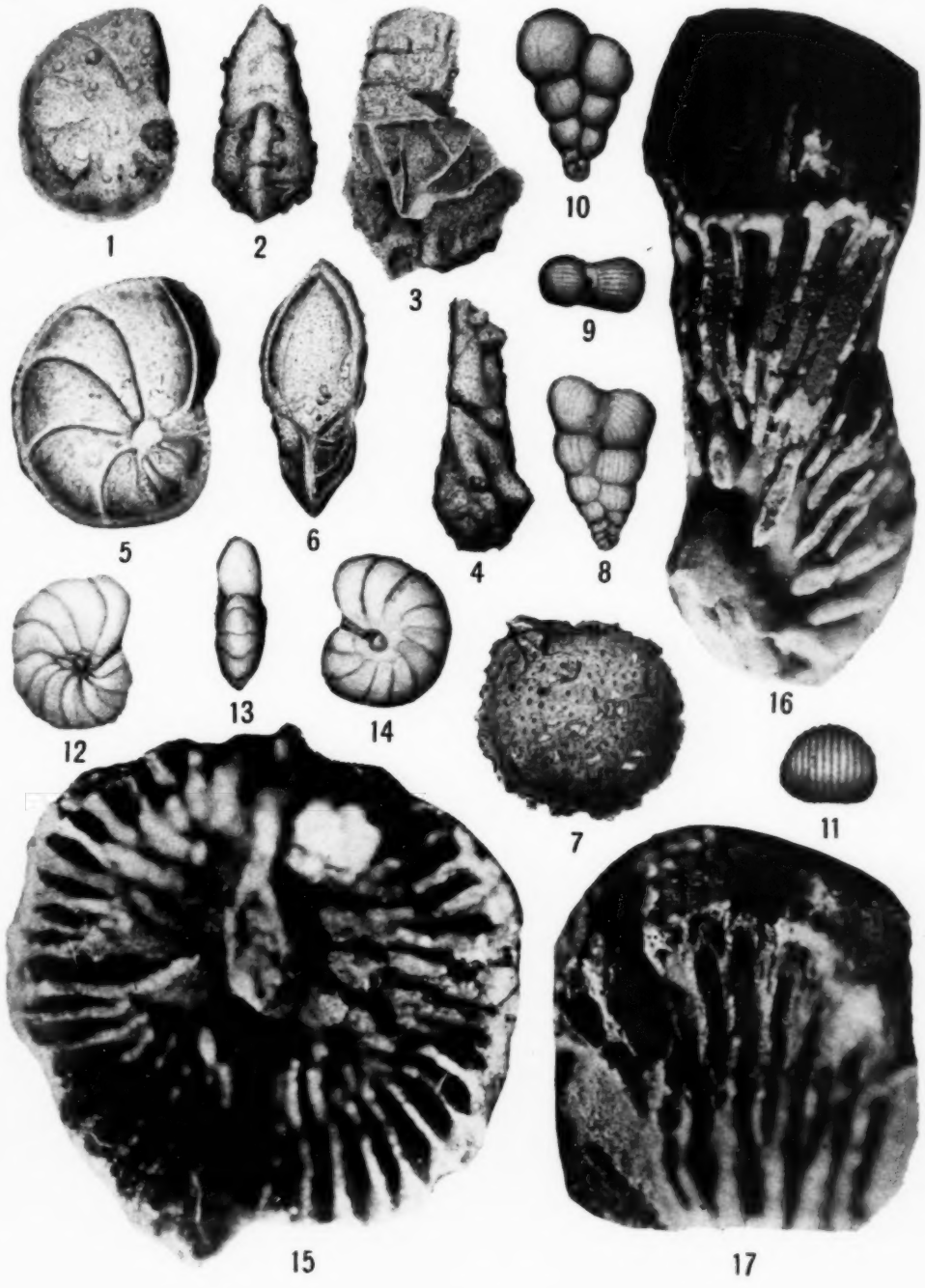
7—*Saccammina* cf. *S. sphaerica* M. Sars; Jurassic, Malone formation, lower division. (p. 20)

8–10—*Gümbelina paucistriata* Albritton, n. sp., Lower Cretaceous, basal sandstone of Torcer formation. *8, 9*, Holotype, megalospheric form, side and apertural views; *10*, microspheric form, side view. (p. 22)

11—*Lagena?* sp., Lower Cretaceous, basal sandstone of Torcer formation. (p. 21)

12–14—*Anomalina torcerensis* Albritton, n. sp., holotype, dorsal, side, and ventral views; Lower Cretaceous, basal member of Torcer formation. (p. 22)

15–17—*Malonophyllum texanum* Okulitch and Albritton, n. gen. and sp., syntypes; Permian, Texas. *15*, View, ×4⅓, showing simple, thick septa, parietal columella formed of counterseptum, and lack of dissepiments. *16*, View, ×5, showing details of septa and longitudinally striated theca formed by bifurcating ends of septa. *17*, View, ×5, showing septa, theca, epitheca, and costae. (p. 24)



Albritton, Jurassic and Cretaceous Foraminifera
Okulitch and Albritton, Permian Coral

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The species appears to be closely related to *Anomalina falcata* Reuss, a form which has been reported from the Upper and Lower Cretaceous of Texas (8*a*). From *A. falcata* the Malone species may be distinguished by its uniformly depressed sutures and possibly by its greater degree of involution.

Holotype: Cushman Coll. 22536; basal sandstone and conglomerate member, Torcer formation, V-Canyon, Malone Mountains.

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JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 24–25, JANUARY, 1937

MALONOPHYLLUM, A NEW TETRACORAL FROM THE PERMIAN OF TEXAS

VLADIMIR J. OKULITCH AND CLAUDE C. ALBRITTON, JR.
Harvard University, Cambridge, Massachusetts

ABSTRACT

Malonophyllum, a new zaphrentid from Hudspeth County, Texas, occurs in rocks correlated with the Leonard formation. It differs from *Zaphrentis* in the presence of a parietal columella; from both *Zaphrentis* and *Lophophyllum* in the absence of tabulae and dissepiments.

The specimens here described were collected from the Malone Hills, north of Torcer Station, Hudspeth County, Texas. The Permian faunule at this locality was recognized and reported by C. L. Baker in 1927 (1). That year from the same locality J. W. Beede collected species which he compared with those of the Leonard formation of the Glass Mountains (2).

In 1935, in the course of a field study that included the Malone Hills, M. P. Billings, J. D. Boon, Jr., C. C. Albritton, Sr., and C. C. Albritton, Jr. made extensive collections which have confirmed the Leonard age of the containing limestones. Included in this collection were a dozen or so silicified, fragmentary coralla which were found to differ significantly from zaphrentids cited in the literature. The new genus *Malonophyllum* is proposed for these corals.

SYSTEMATIC DESCRIPTIONS

Family ZAPHRENTIDAE Milne-Edwards and Haime

Genus MALONOPHYLLUM Okulitch and Albritton, n. gen.

Corallum simple, turbinate. Septa thick, tetramerally arranged. Columella lophophylloid, formed by extension of counter septum. Fossula single, deep, marking position of cardinal septum. Tabulae and dissepiments absent. Genotype, *Malonophyllum texanum* Okulitch and Albritton.

Differs from *Zaphrentis* in the presence of a parietal columella; from both *Zaphrentis* and *Lophophyllum* in the absence of tabulae and dissepiments.

MALONOPHYLLUM TEXANUM Okulitch and Albritton, n. sp.

Plate 4, figures 15–17

Corallum simple, sub-conical. Septa simple, thick, lamelliform, meeting in center of coral in early growth stages, later exhibiting a tendency to withdraw slightly from the parietal columella (maximum withdrawal observed one-seventh length of septum concerned); septa strongly deflected toward counter septum; 40 septa observed in the holotype (diameter, 15 mm.). Counter septum thickened at inner end to form prominent parietal columella, which appears to be concentrically lamellar, probably because the inner end of the counter

septum makes a complete loop; columella smooth, strongly compressed and blade-like in younger stages, elongate-elliptical in mature stage with ratio of long to short axis 12:5. Fossula prominent, deep; cardinal septum rudimentary. Tabulae and dissepiments lacking in all specimens observed. Theca formed by fusion of outer ends of septa, which in well preserved specimens may be observed to bifurcate or trifurcate outward; theca longitudinally striate, the striae being of two orders—sharply incised furrows which mark the trace of septal splitting, and faintly impressed linear sutures which mark the fusion of adjacent septa; these latter are often obscure or lacking. Epitheca (preserved only in one fragment) thick, rugose, faintly furrowed externally opposite traces of bifurcation and fusion of septa; costae extend from theca to epitheca.

Measurements: Length approximately 38 mm. Maximum diameter observed, 15 mm.

Locality: Limestone of Leonard (Middle Permian) age outcropping at northwestern end of Malone Hills, one-half mile north of Torcer Station on the Texas and Pacific R. R., southern Hudspeth County, Texas.

It is possible that Girty's *Lophophyllum*? sp., from the Abo sandstone of New Mexico (3), should be referred to *Malonophyllum*. The Abo zaphrentid is reported to lack tabulae and dissepiments and hence cannot be referred to *Lophophyllum* as redefined by Carruthers (4).

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JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 26–28, PL. 5, JANUARY, 1937

CRETACEOUS AND TERTIARY CRABS FROM PANAMA AND COLOMBIA

MARY J. RATHBUN
U. S. National Museum, Washington, D. C.

ABSTRACT

A new Lower Cretaceous crab is described from Colombia, and three Tertiary species from Panama.

Mr. A. A. Olsson has submitted a small collection of fossil crustaceans from the Cretaceous of Colombia and the Tertiary of Panama. The species are new forms, excepting a chela of *Callinectes* which seems to be identical with *C. declivis*.

SYSTEMATIC DESCRIPTIONS

DAKOTICANCRIDAE

DAKOTICANCER OLSSONI Rathbun, n. sp.
Plate 5, figure 6

Upper surface of carapace exposed, also a part of the lower surface; subcircular, wider than long, hind margin straight, horizontal. Front subtriangular, tip lacking, either side raised obliquely in a triangle, and forming the inner angle of the orbit. Outer angle of orbit also suberect but small; a short blunt tooth at middle of orbit. Indication of five shallow lateral teeth, their margins granulate. Hepatic region depressed. Anterior third of carapace showing a few scattered granules; one of these is directly behind the frontal teeth. Mesogastric region narrow; also the cardiac region, pointed behind. Directly behind the mesogastric region a line of granules forms an obtuse angle at middle. On the anterior branchial region there is a narrow ridge, which forms an angle pointing forward at mid-

EXPLANATION OF PLATE 5

FIGS. *1–3*—*Callinectes declivis* Rathbun, left palm; outer, inner, and upper surfaces, ×2; Eocene, Panama. (p. 27)

4—*Montezumella casayetensis* Rathbun, n. sp., holotype; under surface of carapace, ×1.6; upper Oligocene or lower Miocene, Panama. (p. 27)

5—*Lobocarcinus? santosi* Rathbun, n. sp., holotype; dorsal view of carapace, ×1; Eocene, Panama. (p. 27)

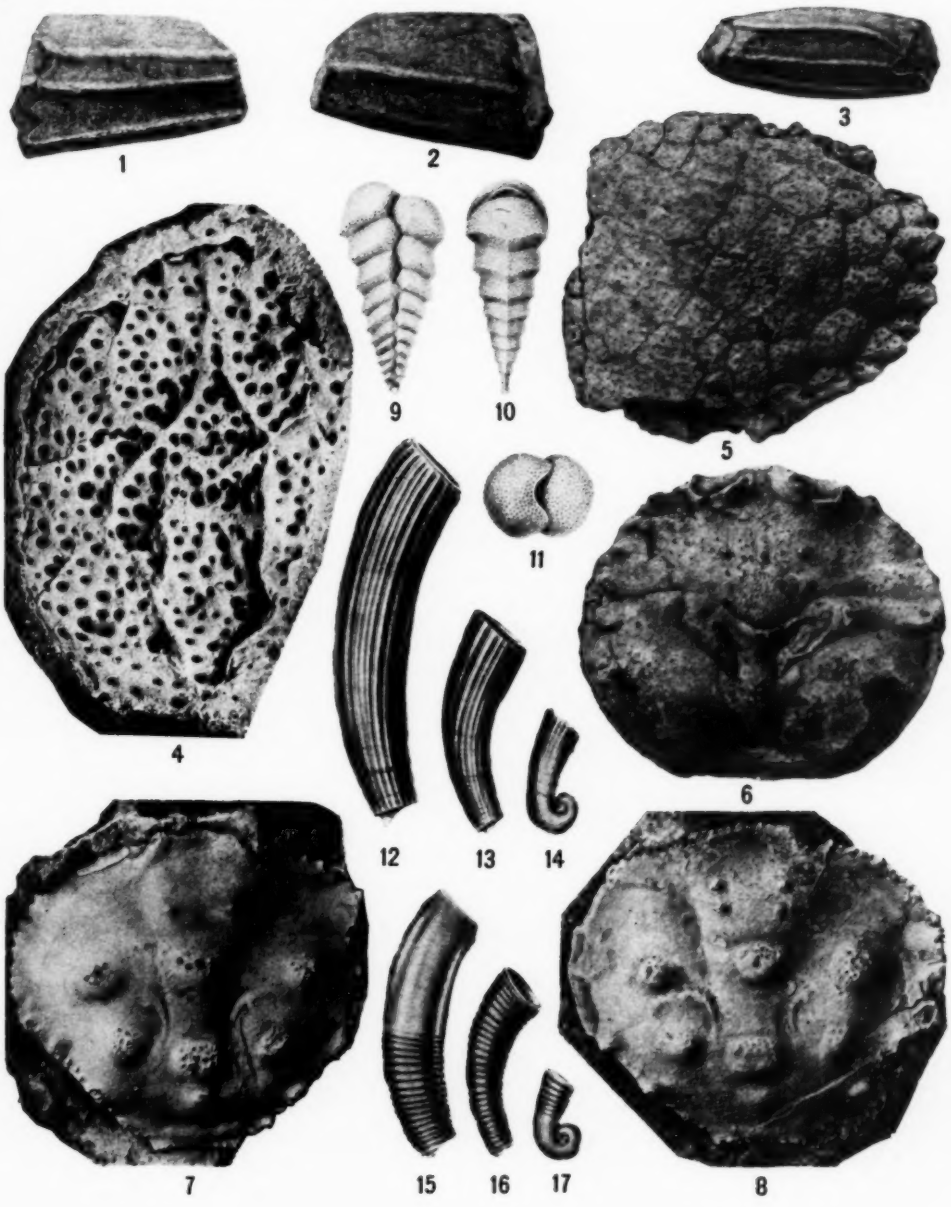
6—*Dakoticancer olssoni* Rathbun, n. sp., holotype; dorsal view of carapace, ×2; Cretaceous, Colombia. (p. 26)

7, 8—*Zanthopsis terryi* Rathbun, n. sp., syntypes; dorsal views of carapace, ×1½; Eocene, Panama. (p. 27)

9–11—*Suggrunda porosa* W. Hoffmeister and C. Berry, n. gen. and sp. holotype, ×100, front, side, and apertural views; middle Miocene, well near Maturin, State of Monagas, Venezuela. (p. 29)

12–14—*Caecum veracruzanum* Collins, n. sp., Middle Miocene, Santa Rosa, Vera Cruz, Isthmus of Tehuantepec, Mexico. *12*, Holotype, adult shell; *13*, *14*, paratypes, intermediate and young shells; ×18. (p. 33)

15–17—*Caecum mexicanum* Collins, n. sp., Middle Miocene, Santa Rosa, Vera Cruz, Isthmus of Tehuantepec, Mexico. *15*, Holotype, adult shell; *16*, *17*, paratypes, intermediate and young shells; ×18. (p. 32)



Rathbun, Cretaceous and Tertiary Crustacea
Hoffmeister and Berry, Miocene Foraminifer
Collins, Miocene Gastropods

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dle, and continues less strongly outward to carapace margin. Branchial regions swollen.

Measurements.—Length of carapace, 21 mm.; width, 24.5 mm.

Occurrence.—Colombia: Curiti, Departmento de Santander del Sur, near junction of branch road leading to the village of Curiti, Eastern Cordillera, from the main auto road from San Gil to Bucaramanga; A. A. Olsson, collector. Cretaceous, Barremian. U. S. Nat. Mus. 495104.

ATELECYCLIDAE

MONTEZUMELLA CASAYETENSIS Rathbun, n. sp.

Plate 5, figure 4

The under surface of a carapace, lacking a margin. General shape elongate-oval. Regions similar to those of *M. tubulata* (1). The sides of the mesogastric region deeply concave, the anterior half very slender; its side margins extended outward and backward in a curve on the branchial region which turns inward to the middle of the cardiac region. Sides of metagastric and cardiac regions subparallel; the intestinal region tapers posteriorly. Protogastric regions well defined, hepatic less so. Surface entirely covered with granules larger than those of *M. tubulata* and less numerous; 24 mesogastric, 16 metagastric, 50 cardiac and intestinal.

Measurements (approximate).—Length of carapace, 39 mm.; width, 34 mm.

Occurrence.—Isla Casayeta, Pearl Islands, Bay of Panama; R. E. Terry, collector. Upper Oligocene or Lower Miocene. U. S. Nat. Mus. 495106.

PORTUNIDAE

CALLINECTES DECLIVIS Rathbun

Plate 5, figures 1–3

Callinectes declivis RATHBUN, *1918 (1919)*, U. S. Nat. Mus., Bull. 103, p. 162, pl. 66, figs. 1–3.

A left manus. Near base of sedimentary series just above basal limestone, Quebrada Platanal, near El Llano, Province of Panama; R. E. Terry, collector. Upper Eocene. U. S. Nat. Mus. 495103.

This specimen corresponds with the type, from Banana River, Costa Rica, which was supposed to be taken from the Gatun formation (Miocene).

CANCRIDAE

LOBOCARCINUS? SANTOSI Rathbun, n. sp.

Plate 5, figure 5

A fragment of a large carapace showing the lateral teeth and a portion of the interior surface. Carapace moderately convex and equally so in all directions, covered with separated punctae and showing no indication of regions. The right margin has a row of ten irregular blunt teeth slightly projecting; beginning in the rear, the first tooth is triangular, second and third straight-lined, the remainder projecting forward a little, and alternating in size. Just within the row of teeth there is a connecting row of low subcircular elevations.

Measurements.—Length of fragment, 45 mm.; width, 50 mm.

Occurrence.—Panama: From Orbitoidal limestone and sandstone series, on coast near Quebrada Marinero, Province of Los Santos; A. A. Olsson, collector. Upper Eocene. U. S. Nat. Mus. 495102.

XANTHIDAE

ZANTHOPSIS TERRYI Rathbun, n. sp.

Plate 5, figures 7, 8

This species is closely allied to *Z. rathbunae* Maury (2), from the Eocene of Venezuela. The carapace is similar in shape, but the postero-lateral margins are more concave and the eight protuberances on the upper surface are lower and less conical. Postero-lateral margins granulate and with three small and shallow tubercles: one at lateral angle, another at a short distance behind, and a third near the posterior end; this last is elongate, higher at upper end, sloping downward and backward. Antero-lateral margins well rounded, granulate, the carapace

wider in front of lateral angle; denticles on either side not far from the angle; small clusters of granules above them, and further forward more numerous granules as far as the orbit. Front advanced, depressed at middle, surface rough with reticulated lines. General surface more or less punctate.

Measurements.—Length of carapace on median line, 28.4 mm.; greatest width, 34 mm.; width at lateral angles, 16.5 mm.

Occurrence.—Near base of sedimentary series just above basal limestone, Quebrada Platanal near El Llano, Province of Panama; R. E. Terry, collector. Upper Eocene. U. S. Nat. Mus. 495105.

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JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 29–30, PL. 5, JANUARY, 1937

A NEW GENUS OF FORAMINIFERA FROM THE MIOCENE OF VENEZUELA AND TRINIDAD

WILLIAM S. HOFFMEISTER
Standard Oil Company of Venezuela, Caripito, Venezuela
and
CHARLES T. BERRY
Johns Hopkins University, Baltimore, Maryland

ABSTRACT

Suggrunda, a relative of *Bolivina*, is based on *S. porosa*, from the middle Miocene of Venezuela and Trinidad.

Many specimens of a new foraminifer were encountered in sediments of medial Miocene age from several oil wells in the State of Monagas and the Federal District of Delta Amacuro, in eastern Venezuela, and in southwestern Trinidad. It is here described and named.

Genus SUGGRUNDA W. Hoffmeister and C. Berry, n. gen.

Etymology: Suggrunda, the low borders or eaves of a roof, in reference to the lateral outline of the specimens.

Genotype: *Suggrunda porosa* W. Hoffmeister and C. Berry.

Test very minute, elongate, tapering, tending to be twisted, biserial throughout; chambers somewhat angular, closely appressed, tending to be spinose; walls calcareous, hyaline, rather coarsely perforated; aperture semi-lunate, at base of apertural face.

To date this genus is known only from the type species.

The relationship of *Suggrunda*, because of the twist of the test and the biserial arrangement of the chambers, is believed to be closest with *Bolivina*. The family assignment of *Bolivina* is disputed, however, Cushman (1) assigning it to the Buliminidae and Galloway (2) placing it in Heterohelicidae. A definite assignment of *Suggrunda*, the writers feel, should be deferred until there is more general agreement on the classification of *Bolivina*. The characteristics which determine the position of this new genus under Cushman's interpretation of the family *Buliminidae* consist of the slight twist of the entire test, which although absent in the type is shown in many specimens; the spinose ornamentation of the chambers; and the perforated walls. According to Galloway (2*a*) the genus *Bolivina* should be placed under the family Heterohelicidae. He makes the following statement concerning this relationship:

> The obvious similarity of *Bolivina* to *Bolivinella*, *Bolivinoides* and *Bolivinita*, which genera are probably no more than species of *Bolivina*, and which belong to the family Heterohelicidae, gives preponderating evidence that the type species *Bolivina* and most of the other species belongs in this family. No known species of *Bolivina* has a coiled beginning, either planispiral or high spired.

Among the differences between *Bolivina* and *Suggrunda* are the amount of twisting of the test, the ornamentation, the angularity of the chambers and the position and shape of the aperture.

SUGGRUNDA POROSA W. Hoffmeister and C. Berry, n. sp.
Plate 5, figures 9–11

Test very minute, 0.29 mm. long, 0.16 mm. wide, 0.11 mm. thick. Width of test gradually increasing from the very acute

initial end up to the last formed chambers. Test biserial throughout, proloculum spherical, located a little asymmetrically (in lateral view) in regard to the entire test; in marginal view proloculum appearing slightly thicker than the second and third chambers, but this difference in size is not apparent in all the specimens belonging to the species. Chambers tending to be angular, giving rise to almost flat surfaces. In the type eleven chambers on one side but only ten on the other, not considering the proloculum. Chambers forming an angle of 60° with vertical axis of test, making a pronounced zigzag suture along the axis in front view; horizontal diameter of chambers greater than the vertical. Although not true of the type, many specimens spinose. Calcareous walls punctured by numerous perforations, from which the specific name *porosa*. Aperture situated at the base of the apertural face, semi-lunate, the slight margins directed inward.

Holotype: U. S. Nat. Mus. 92747.

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JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 31–33, PL. 5, JANUARY, 1937

GROWTH STAGES OF MEXICAN TERTIARY CAECIDS

R. LEE COLLINS
Johns Hopkins University, Baltimore, Maryland

ABSTRACT

Caecum mexicanum and *C. veracruzanum*, are described from the middle Miocene beds of Mexico. Three figures are presented for each species to show the differences in the appearance of young, intermediate and adult shells.

The shell of a single individual in the genus *Caecum* has a rather distinctive appearance for each of the several growth stages of the organism. This difference during growth has been known for many years, but the stages of shell development in fossil forms are very rarely described or figured (1). Considered briefly, there are three well marked stages in each individual. The shell begins with a minute, symmetrically coiled, planispiral apex consisting of several whorls, from which the younger part of the shell extends as a gently arched tube. When this tube has become large enough to contain all of the soft parts, they are withdrawn from the older part of the shell; the apical, unused portion is then cut off and lost; and the opening that is left at the apical end is sealed by a more or less projecting plug of shell material. The second stage continues as a gently enlarging, slightly arched tube with the aperture at the widest part of the shell. In the third or adult stage, the aperture is slightly constricted and in some forms a definite thickened lip is developed. The widest part of the adult shell is generally just behind the aperture and the shell in some species is ornamented by annulations or longitudinal ribs.

Dall (2) states that the shell of the second stage has only traces of the adult sculpture, "annulate species may be nearly smooth when in the second stage." This condition may hold for some of the annulate or otherwise sculptured forms, but is not the case in either of the Mexican species herein described. In both of these forms the sculpture begins at the protoconch, or nucleus, and in the annulate species the reverse condition is true, that is, the annulations disappear toward the aperture of the adult shell. In the longitudinally ribbed species the ornamentation continues from the nucleus to the aperture.

The first record of Tertiary caecids from Mexico was published by Engerrand and Urbina (3) in 1910. Fifteen specimens were reported from the Miocene of Zuluzum in Chiapas, but not identified, described or figured. Neither Böse nor Toula mention them in the Santa Rosa fauna from other Mexican localities.

Collections from Santa Rosa that are in the United States National

Museum and in the Johns Hopkins University contain well over a thousand of these small gastropod shells. It was possible to work out from this abundance of material a rather complete series of growth stages for the two species described below. Three of the stages are figured for each species. The youngest stages figured show the smooth and coiled nucleus, or protoconch, and a part of the ornamented second stage. The nucleus alone, in the Mexican specimens at least, is not distinctive enough to be assigned to any one particular species and it is possible to determine them only when part of the second stage is present to show the characteristic ornamentation. The intermediate stage has the aperture at the widest part of the shell, the tube is more strongly arched and increases in diameter more rapidly than the adult shell. The widest part of the adult shell is just below the slightly constricted aperture.

The youngest stages of these Mexican species were found, almost without exception, in material that was cleaned from the interior of larger gastropod shells and examined without preliminary washing. The shells are so fragile that most of them would probably have been destroyed if the material had been washed before examination.

SYSTEMATIC DESCRIPTIONS

CAECUM MEXICANUM Collins, n. sp.
Plate 5, figures 15–17

Shell relatively small, tubular, gently arched, slightly tapering; aperture oblique to axis of shell, constricted; apex blunt, oblique, sealed by a plug with a small, sharp point placed toward the right and projecting very little beyond the shell wall. Exterior ornamentation consisting of close-set, evenly developed annulations on the apical half of the shell, beyond which the surface toward the aperture is smooth and polished, showing only faint growth lines.

Types: Johns Hopkins Univ. coll. Holotype, adult, length, 1.95 mm.; maximum diameter, 0.46 mm.; diameter at aperture, 0.38 mm.; apical diameter, 0.30 mm. Paratype, second stage, length, 1.33 mm.; maximum diameter, 0.38 mm.; apical diameter, 0.20 mm. Paratype, first stage, length, 0.59 mm.; diameter of aperture, 0.25 mm.; diameter of protoconch, 0.33 mm.

Type locality: Santa Rosa, Vera Cruz, Isthmus of Tehuantepec, Mexico. Middle Miocene.

Remarks.—This is the most common species of caecid from the Santa Rosa locality. It probably belongs to the group of *C. regulare* Carpenter, an upper Miocene to Recent species in the southeastern United States and Antillean region, but seems to be quite distinct from any of the known species of this group. In many of the annulate forms there is a marked tendency for the annulations to become elevated and much more pronounced toward the aperture, whereas in the Mexican species the sculpture disappears toward the aperture. *C. mexicanum* is one of the smaller caecids, approaching in size, but slightly larger than *C. properegulare* Mansfield (4), a middle or lower Miocene species from the island of Trinidad. The latter species has sharper annulations that continue from the apex to the aperture of the shell. *C. patuxentium* Martin (5) from the Choptank Miocene of Maryland is a somewhat larger species in which the annulations are lower and more evenly developed, but in this species also the ornamentation continues to the aperture.

CAECUM VERACRUZANUM Collins, n. sp.
Plate 5, figures 12–14

Shell relatively small, tubular, gently arched, moderately tapering; aperture oblique to axis of shell, constricted; apex blunt, oblique, sealed by a plug with a small sharp point directed to the right and projecting slightly beyond the end of the shell wall. Exterior ornamentation consisting of longitudinal ribs and interspaces of about equal width running from the apex to the aperture.

Types: Johns Hopkins Univ. coll. Holotype, adult, length, 2.87 mm.; maximum diameter, 0.62 mm.; diameter at aperture, 0.53 mm.; apical diameter, 0.35 mm. Paratype, second stage, length, 1.6 mm.; maximum diameter, 0.48 mm.; apical diameter, 0.25 mm. Paratype, first stage, length, 0.87 mm.; diameter of aperture, 0.28 mm.; diameter of protoconch, 0.33 mm.

Type locality: Santa Rosa, Vera Cruz, Isthmus of Tehuantepec, Mexico. Middle Miocene.

Remarks.—This species is not so abundant in the collections as *C. mexicanum*, is slightly larger and bears entirely different ornamentation. It is smaller than and lacks the characteristic twist of *C. tortile* Dall from the Miocene and Pliocene of the southeastern United States. It is smaller than *C. ibex* Dall from the same region and does not have such a conspicuous apical plug as either of Dall's species (2*a*). The ornamentation is more like that of *ibex* than that of *C. stevensoni* Meyer (6) from the Yorktown Miocene of Virginia. This species has much stronger longitudinal ribs, is larger than the Mexican species, but does have a small and quite similar apical plug.

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JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 34–37, 2 TEXT-FIGS., PL. 6,
JANUARY, 1937

AMMONITES OF THE GENERA *SONNERATIA* AND *DOUVILLEICERAS* FROM THE CRETACEOUS OF COLOMBIA

GAYLE SCOTT
Texas Christian University, Fort Worth, Texas

ABSTRACT

Sonneratia colombiana and *Douvilleiceras* cf. *D. inaequinodum* indicate middle Albian horizons in the sequence of Cretaceous rocks in Colombia.

In 1931 one of my former students, Mr. Olleon Carrell, gave me a small collection of fossils from South America, among which are a species of *Sonneratia* and one of *Douvilleiceras* that appear to be of some interest. Both species are represented by rather unusually fine specimens preserved as iron-stone casts, and both are of the Albian age, although they appear to be from slightly different horizons.

The genus *Sonneratia* characterizes the lower middle Albian beds below the zone *Douvilleiceras mammillatum* and therefore accurately dates the steeply dipping beds of dark shales and limestones at Conchal, Santander, Colombia, that yielded the holotype of *S. colombiana*.

The *Douvilleiceras*, *D.* cf. *inaequinodum*, was collected on the Cuesta del Diablo, Santander, Colombia. The strata here, according to Carrell, consist of gray to dark shales and sandstones, more or less bituminous marls and sandy marls with echinoids and near-shore mollusks; and richly fossiliferous shales and limestones. The thickness is from 1,500 to 2,000 feet, being greatest in the vicinity of the mountains. Carrell thought it possible that these beds might belong to the Villeta formation. The Villeta is supposed to be of Barremian age, but it is probable that the term, as used, covers also strata of much later age.

It should be noted that D'Orbigny (1) described *Ammonites solitae* from the Villeta beds of Loma del Petaquero. He mentioned that his species was closely related to *A. mammilatus* Schloth. He also described *A. guaduasensis* from the same beds and compared it to *A. nodocostatus*, a species which has been referred to *Douvilleiceras*. Eliane Basse (2) and R. Douvillé (3) have reported from the northern Andes several species of the closely related genus *Cheloniceras*, including *C. stoliczkianum* Gabb, common in the Albian of California. *Ammonites offarcinatus* White (4), from Brazil, appears to be a *Douvilleiceras*.

Species of the group of *D. inaequinodum*, however, have not previously been reported from the Western Hemisphere. *D. inaequinodum* is definitely early medial Albian in age, and in Europe occupies a stratigraphic level a little above species of *Douvilleiceras* of the group of *D. mammillatum* (5*a*).

SYSTEMATIC DESCRIPTIONS

DOUVILLEICERAS cf. D. INAEQUINODUM (Quenstedt)

Plate 6, figures 3, 4. Text-figure 1

Measurements:	mm.
Length of fragment	140
Height of whorl	55
Thickness of whorl	69

This description is based upon a single large fragment, consisting of a part of one whorl, well-preserved, showing sculpture and suture in great detail, and preserving the inner layers of fragments of the shell.

Shape agreeing well with that of figured specimens of *D. inaequinodum* (5*b*), although considerably larger than any specimen known to me; whorls heavy-bodied, broader than high, broadly rounded, evolute. Sculpture of very unequal, irregularly spaced, multituberculate costae; costae broad, broadly rounded, widely spaced; inclined posteriorly, especially near the venter, a character more marked in the present specimen than in any figured specimens known to me, or in any of a number of fragments of the species in my collection from France, though the character may be associated with the more mature stage of the fragment from South America; costae all briefly interrupted or greatly attenuated in traversing the venter. Primary costae great, thick, flared structures of unequal prominence, with large bullate ventrolateral tubercles; between the primaries one or two unequal, unevenly-spaced secondaries. Tubercles on the large cast tending to become very broadly rounded, less prominent than in European specimens before me, but quite distinct, slightly compressed spirally, and occurring in seven well defined rows. Suture especially diagnostic, characterized by an unusually deep first lateral saddle and complex first lateral lobe.

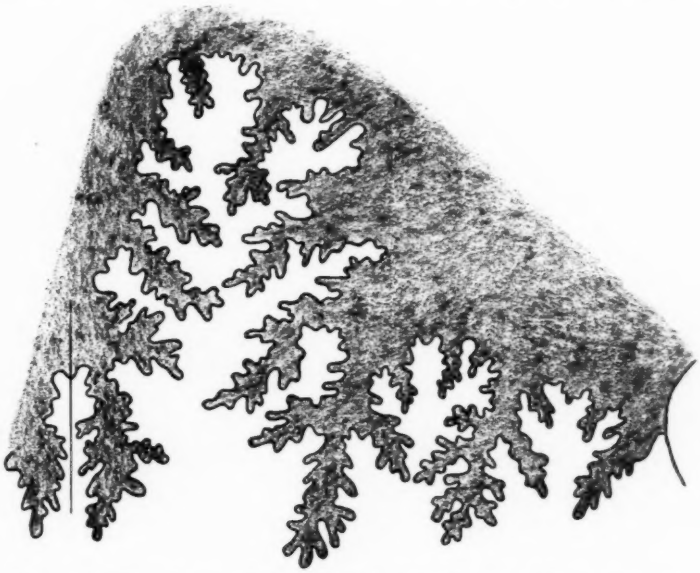


FIG. 1—*Douvilleiceras* cf. *D. inaequinodum* (Quenstedt), suture, ×1.

Remarks.—Because of the differences noted above the specimen from Colombia is not definitely referred to *D. inaequinodum*, a species easily distinguished by its

robust sculpture and characteristic suture pattern, from any other species of *Douvilleiceras*. It is possible that the various ammonites referred to *D. inaequinodum* constitute a group rather than a single species. The specimen here described represents the first record in the Western Hemisphere of this important group. Perhaps the group should be separated under a new generic name, though with only a small collection at hand I hesitate to take this step for fear of needlessly complicating the already complex paleontological nomenclature.

FIG. 2—*Sonneratia colombiana* Scott, n. sp., suture of holotype, ×¾.

Horizon and Locality.—Lower middle Albian; Cuesta del Diablo, from dark argillaceous, bituminous shales and sandstones, intercalated with dark thin-bedded limestones. The Cuesta del Diablo is 60 km. east and 41 km. north of Puerto Wilches, Santander, Colombia.

Figured specimen.—Texas Christian Univ. Dept. Geol. 1107.

SONNERATIA COLOMBIANA Scott, n. sp.
Plate 6, figures 1, 2. Text-figure 2

Measurements:	mm.
Diameter	91
Greater radius	54
Lesser radius	37
Height of last whorl	41
Height of penultimate whorl	19
Thickness of last whorl	30
Thickness of penultimate whorl	18.5
Width of umbilicus	24
Height of umbilical wall	6
Suture taken at diameter of	58

This species is based upon a nearly perfect internal mold with most of the living chamber attached and with considerable portions of the original shell material adhering at places, and upon a number of small fragments of the same species, broken from the matrix of the large example, which help to determine the characters of the earlier whorls.

Shell moderately globose, evolute, with wide umbilicus showing about one-third of previous whorls; umbilical wall low, sloping gently away from the umbilical suture; umbilical margin broadly rounded, indistinct. Whorls inflated, increasing rapidly in height, slowly in thickness; venter broadly arched; flanks broad, slightly rounded. Sculpture of prominent, widely spaced, sharply rounded, flexuous primary and secondary costae; primary and secondary costae alternating regularly, inclining sharply forward in crossing the flanks and venter; on very young whorls a distinct flattening of the ribs as they cross the venter, on older whorls only a little loss of prominence; on the venter primary and secondary costae of about equal prominence, on the flanks secondaries disappearing at about the middle; primary costae becoming increasingly prominent toward dorsal part of flank, then gradually fading away on

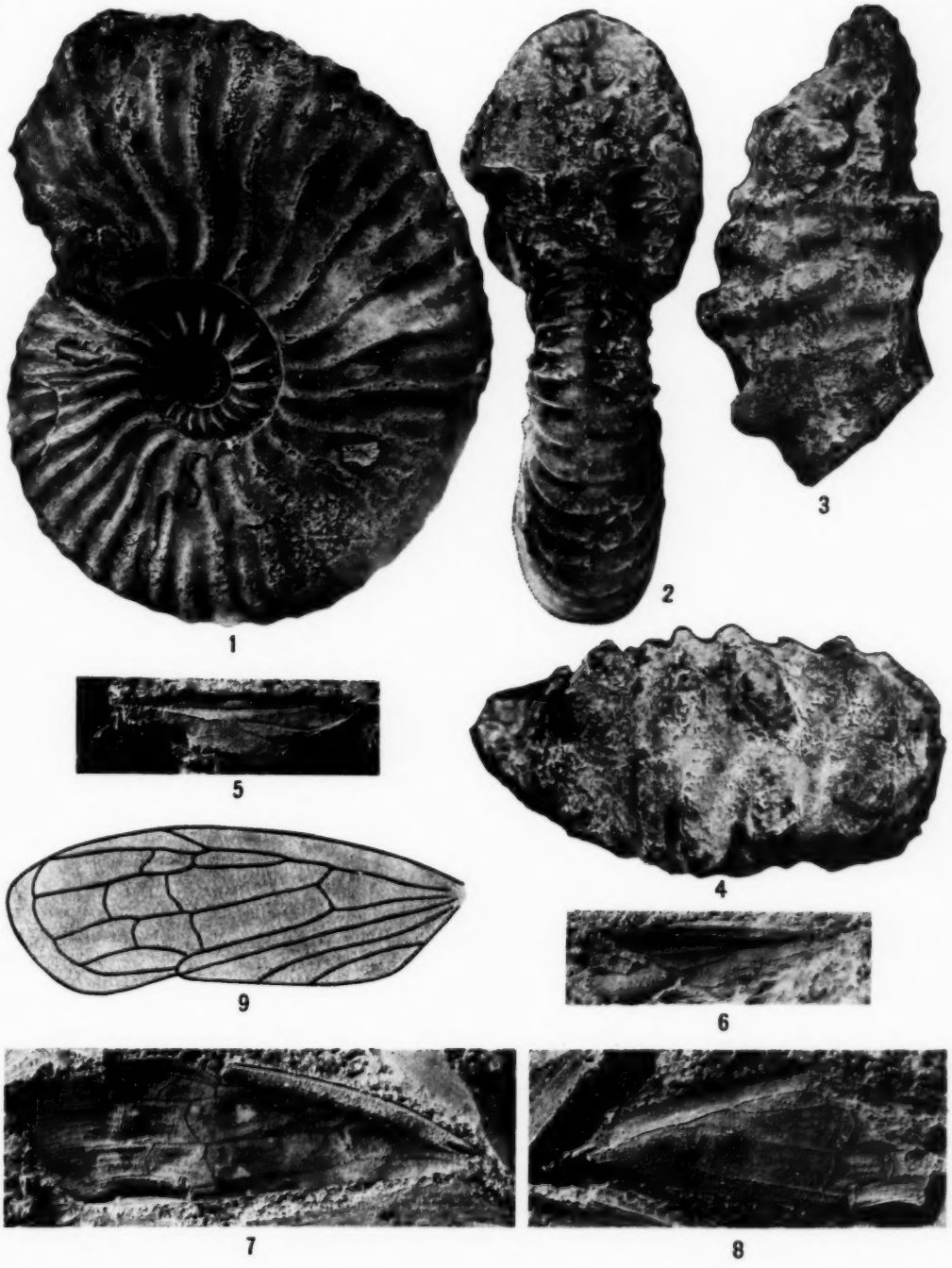
EXPLANATION OF PLATE 6

FIGS. *1, 2*—*Sonneratia colombiana* Scott, n. sp., holotype, lateral and apertural views, ×1; Cretaceous, middle Albian, Conchal, Santander, Colombia. (p. 36)

3, 4—*Douvilleiceras* cf. *D. inaequinodum* (Quenstedt), lateral and ventral views, ×½, of part of a whorl; Cretaceous, middle Albian, Cuesta del Diablo, Santander, Colombia. (p. 35)

5, 6—Hemielytron of an insect of the family Coreidae, original and counterpart, ×6; Cretaceous, Fox Hills sandstone, Adams County, Colorado. (p. 37)

7–9—*Mesojassoides gigantea* Oman, n. gen. and sp., holotype; original, counterpart, and reconstruction of complete wing, ×6; Cretaceous, Fox Hills sandstone, Adams County, Colorado. (p. 37)



Scott, Cretaceous Ammonites
Oman, Cretaceous Insects

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umbilical wall. No tubercles. Suture characterized by low, broad lobes; ventral lobe broad, a little lower than first lateral; first lateral lobe asymmetrically trifid, ventral branch being separated by a much deeper secondary saddle than the dorsal branch; second lateral lobe near umbilical margin; third on the umbilical wall; first lateral saddle broad.

Remarks.—In many respects *Sonneratia colombiana* is similar to *S.* aff. *S. kitchini* Spath (5*c*), but its costae are narrower, more closely spaced, and more flexuous; and the suture does not appear to be as finely dissected. The new species also closely resembles *Ammonites treffryanus* Karsten (6) from Tocaima, in the Magdalena Valley not far from Bogota. Karsten's species, however, is not described and the suture is not figured. The shape and general appearance of the fossils are very similar, but *S. colombiana* shows a regular alternation of primary and secondary ribs, whereas *A. treffryanus* has as many as three secondary costae between primaries. *A. treffryanus* appears to be a member of the genus *Sonneratia*.

Horizon and Locality.—Lower middle Albian; dark shales and limestones in a railroad cut about one-fourth mile east of the station of Conchal, Department of Santander, Colombia. Conchal is 70 miles east of Puerto Wilches, on the narrow gage railroad from Puerto Wilches to Bucaramanga, near the headwaters of Rio Lebrija.

Holotype.—Texas Christian Univ. Dept. Geol. 1108.

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FOSSIL HEMIPTERA FROM THE FOX HILLS SANDSTONE (CRETACEOUS) OF COLORADO

PAUL W. OMAN
Bureau of Entomology and Plant Quarantine, U. S. Department of Agriculture, Washington, D. C.

ABSTRACT

Mesojassoides gigantea, a fossil leafhopper, is described from the Fox Hills sandstone of eastern Colorado, and the presence of a member of the heteropterous family Coreidae is suggested.

So few American Cretaceous insects have been described that any record of their occurrence is of interest. In the present paper are described a homopterous form, represented by a nearly complete forewing, and a heteropterous form, represented by a hemielytron. The specimens were found in a calcareous concretion collected from the Fox Hills sandstone of eastern Colorado by Messrs. C. H. Dane and W. G. Pierce, of the U. S. Geological Survey, and were associated with a number of species of marine mollusks, fragments of fossil wood, and a few rolled, indeterminable fossil leaves.

The Fox Hills sandstone, because of its fauna and of its position in the sequence of formations, is usually correlated with the upper Maestrichtian of the European sequence.

The writer is indebted to Dr. J. B. Reeside, Jr., for the opportunity of studying the material and to Dr. G. Arthur Cooper for the excellent photographs of the specimens.

HOMOPTERA

CICADELLIDAE

MESOJASSOIDES Oman, n. gen.

Apparently more closely related to *Jassus* Fabricius than to any other modern genus. Venation of forewing similar to that of *Jassus* in having the radius forked and the media unforked on the disk of the corium, but differing in having additional cross-veins anterior to the apical series. Appendix unusually large and extending around the entire apex of the forewing.

Type of the genus, *Mesojassoides gigantea* Oman.

MESOJASSOIDES GIGANTEA Oman, n. sp.

Plate 6, figures 7–9

Length of forewing, 12 mm. Apical one-third of wing apparently more membranous than basal portion and showing distinct longitudinal corrugations. Costal area with an oblique vein to costal margin from near apex of first cell formed by furcation of radius.

The foregoing description is based on an excellent imprint, representing an entire forewing with the exception of the clavus and small portions of the costal margin. The wing indicates a leafhopper about the size of the largest known forms.

Type locality.—Fox Hills sandstone, 500 ft. south of the E. $\frac{1}{4}$ cor. sec. 27, T. 1 S., R. 58 W., Adams County, Colorado, collected by C. H. Dane and W. G. Pierce, 1932.

Holotype.—U. S. Nat. Mus. 75521.

HETEROPTERA

COREIDAE; genus and species doubtful

Plate 6, figures 5, 6

On the piece of sandstone containing the previous species there is the imprint of a hemielytron of a heteropterous insect. Mr. H. G. Barber has examined the print and states that it is probably a coreid but too incomplete to warrant description.

Figured specimen.—U. S. Nat. Mus. 75522.

JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 39–42, PL. 7, JANUARY, 1937

NEW SPECIES OF CAMBRIAN TRILOBITES OF THE FAMILY CONOCORYPHIDAE

CHARLES E. RESSER
U. S. National Museum, Washington, D. C.

ABSTRACT

Ten new species belonging to five of the seven genera now recognized in the trilobite family Conocoryphidae are described.

Incidental to checking the U. S. National Museum collections for the writer's summary of the Cambrian, now nearing completion, the previously identified trilobites of the family Conocoryphidae were briefly studied and all references appearing in publications reviewed. As duplication and misuse of names were discovered, and as a more logical generic rearrangement was found possible, the results of these brief studies were incorporated in a paper on nomenclatural changes (1). Ten new species were noted, but they were not included in the nomenclatural paper because it lacked illustrations. Description of these species presented here, together with the discussion of the family in the nomenclatural paper, should facilitate future study of the Conocoryphidae.

SYSTEMATIC DESCRIPTIONS

Family CONOCORYPHIDAE Angelin, 1878

As pointed out in the brief revision of this family noted above, seven genera are necesxary to care for the known species:

Conocoryphe Corda, 1847; genotype, *Trilobites sulzeri* Schlotheim.

Ctenocephalus Corda, 1846; genotype, *Conocephalus coronatus* Barrande.

Bailiella Matthew, 1885; genotype, *Conocephalites baileyi* Hartt.

Bailiaspis Resser, 1936; genotype, *Conocephalites elegans* Hartt.

Holocephalina Salter, 1864; genotype, *H. primordialis* Salter.

Dasometopus Resser, 1936; genotype, *Harpides breviceps* Angelin.

Hartshillia Illing, 1915; genotype, *Holocephalina inflata* Hicks.

Hartella Matthew is judged to be a synonym of *Ctenocephalus*. *Liocephalus* Grönwall is invalid for two reasons; first, the genotype he chose belongs to *Bailiella*, and second, his concept of the genus was evidently that of Salter's *Holocephalina*. *Erinnys* was the name first given by Salter to *Bailiella*, but, because this name was preoccupied, Walcott substituted *Salteria*, unfortunately also preoccupied. Meanwhile Matthew proposed *Bailiella* without, however, recognizing its relationship to *B. venulosa* Salter, the type of *Erinnys*.

This brief résumé should suffice for a proper understanding of the subsequent descriptions.

Genus CONOCORYPHE Corda, 1847

CONOCORYPHE TERRANOVICA Resser, n. sp.
Plate 7, figures 7, 8

Two cephala in a single piece of calcareous rock constitute the material in hand. These had been identified as *Bailiella baileyi* and indeed are transitional between it and the species of *Conocoryphe*.

C. terranovica is much more granulose than the genotype, *C. sulzeri;* it has the bar before the glabella—the characteristic feature of *Conocoryphe*—less well defined, because the furrows delimiting it are shallow; and it lacks the "eyelines."

It is possible, of course, that *C. terranovica* should be put into *Bailiella*, since it lacks the eye ridge and has such a poorly defined bar in the preglabellar area. However, since the characteristic feature of *Bailiella* is the complete lack of this bar through non-development of the two furrows running forward from the anterior angles of the glabella, it seems more logical to place the new species in *Conocorphe.*

Middle Cambrian, Manuels; (loc. 6*w*) Seal Point Cove, Trinity Bay, Newfoundland.

Holotype.—U. S. N. M. 92059.

Genus BAILIELLA Matthew, 1885

BAILIELLA ORNATA Resser, n. sp.
Plate 7, figures 18–21

Several cephala from the abundantly fossiliferous black shales of Manuels Brook have been identified in published faunal lists as *Bailiella baileyi*, but are now separated from it. No doubt when all the specimens from this locality are studied carefully, additional cephala, and possibly also pygidia of this and of the several other species will be found, supplementing the scanty material now available.

B. ornata is at once distinguishable from *B. baileyi* by its surface markings. Size and shape, however, are little different. *B. baileyi* has lines and widely scattered granules marking its surface, whereas, as can be seen in the figures, *B. ornata* lacks the lines but has numerous large granules rather closely crowded on the surface of the test.

Middle Cambrian, Manuels; (loc. 1) Manuels Brook, Conception Bay, Newfoundland.

Types.—Holotype, U. S. N. M. 92061; paratype, 92061*a;* unfigured paratypes, 92061*b–d.*

Genus BAILIASPIS Resser, 1936

BAILIASPIS VENUSTA Resser, n. sp.
Plate 7, figures 24, 25

A single cephalon formerly identified as *B. elegans* was set aside years ago for

EXPLANATION OF PLATE 7

FIGS. *1–4—Holocephalina americana* Resser, n. sp.; Middle Cambrian, Manuels; (loc. 1) Manuels Brook, Conception Bay, Newfoundland. *1,* Uncompressed cephalon in a limestone nodule, ×1; *2,* cephalon with a portion of the thorax, ×2; *3,* holotype cephalon, showing surface features, ×2; *4,* another head, ×1. (p. 42)

5, 6—Bailiaspis prominens Resser, n. sp.; the holotype cephalon, ×1, and enlargement, ×4, of the right anterior quadrant to show ornamentation; occurrence same as preceding (loc. 1*a*). (p. 41)

7, 8—Conocoryphe terranovica Resser, n. sp., holotype cephalon, ×1, preserved in a limestone nodule, and enlargement, ×4, of the anterior portion of glabella and brim; Middle Cambrian, Manuels; (loc. 6*w*) Seal Point Cove, Trinity Bay, Newfoundland. (p. 39)

9, 10—Ctenocephalus angelini Resser, n. sp., views, ×2 and ×4, of the holotype cephalon; Middle Cambrian, Andrarum limestone; (loc. 8*w*) Andrarum, Skåne, Sweden. (p. 42)

11, 12—Ctenocephalus howelli Resser, n. sp.; right half, ×4, and dorsal view, ×1, of the holotype cephalon; occurrence same as figure 1. (p. 41)

13, 16, 17—Ctenocephalus terranovicus Resser, n. sp.; *13,* impression of a large cephalon ×1, paratype; *16, 17,* views, ×4, of the holotype cephalon; occurrence same as preceding. (p. 41)

14, 15—Ctenocephalus excavatus Resser, n. sp.; left half, ×4, and dorsal view, ×1, of this peculiar cephalon; occurrence same as preceding. (p. 41)

18–21—Bailiella ornata Resser, n. sp.; *18, 19,* views, ×4, of the holotype cephalon; *20, 21,* similar views, ×4, of an impression of a paratype cephalon; ocurrence same as preceding. (p. 40)

22, 23—Ctenocephalus bucculentus Resser, n. sp., views, ×1 and ×4, of the holotype cephalon; occurrence same as preceding. (p. 41)

24, 25—Bailiaspis venusta Resser, n. sp., the holotype cephalon, ×1 and ×4; occurrence same as preceding. (p. 40)

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illustration as part of the Manuels fauna, but is now separated as new. Like *B. elegans*, the new species is marked by fine and coarse sets of granules, but in contrast it has the larger set both much more numerous and relatively larger than in *B. elegans*.

Occurrence same as preceding (loc. 1*a*).

Holotype.—U. S. N. M. 92062.

BAILIASPIS PROMINENS Resser, n. sp.
Plate 7, figures 5, 6

Another single cephalon must be recognized as a new species. At first glance this form seems to belong to *Ctenocephalus*, but, as shown in the illustrations, the anterior prominence is not the boss of *Ctenocephalus* but simply the thickened central portion of the rim, set off by the anterior furrow as it swings back to join the anterior dorsal furrow—the feature which distinguishes *Bailiaspis*.

B. prominens, besides being set off by the prominence of its thickened rim, is further characterized by the sharp taper of its glabella and by the surface markings. The latter consist of a set of fine granules arranged in irregular lines, together with a more scattered set of large granules.

Occurrence same as preceding.

Holotype.—U. S. N. M. 92063.

Genus CTENOCEPHALUS Corda, 1847

Four species of *Ctenocephalus* have been in the National Museum collections from Newfoundland. One is near *C. matthewi* of New Brunswick, but the other two are more distinct.

In the writer's 1936 paper *C. solvensis* Hicks was omitted from the list of valid species for this genus.

CTENOCEPHALUS TERRANOVICUS Resser, n. sp.
Plate 7, figures 13, 16, 17

Three cephala, formerly identified as *C. matthewi*, constitute the fine new species. *C. terranovicus* is distinguished from *C. matthewi* by the greater prominence of its elevated portions, particularly the cheek lobes, which rise into sharp ridges, by its narrower form; and by its more strongly developed surface features.

Occurrence same as preceding.

Types.—Holotype, U. S. N. M. 92064; paratype, 92064*a;* unfigured paratype, 92064*b*.

CTENOCEPHALUS BUCCULENTUS Resser, n. sp.
Plate 7, figures 22, 23

A small, somewhat incomplete cephalon associated with *C. terranovicus* resembles that species, but careful comparison shows that it is distinct. Its anterior margin is straighter; the boss is rounder and consequently more prominent; the swelling of the cheeks reaches its maximum farther back, nearer the genal angle; and finally the surface is characterized by more numerous, coarser granules.

Occurrence same as preceding.

Holotype.—U. S. N. M. 92065.

CTENOCEPHALUS HOWELLI Resser, n. sp.
Plate 7, figures 11, 12

Three cephala, previously identified in the collections as *C. coronatus*, clearly represent two additional species, here named *C. howelli* and *C. excavatus*. In the development of the "eyeline" into a rather high ridge and in the steep slope of the cephalic parts anterior to this ridge both agree exactly with the original definition of *Ctenocephalus*.

Two of the cephala, here named *C. howelli*, are characterized by very prominent surface granules, which are underlain as usual by a fine set.

Occurrence same as preceding (loc. 1).

Types.—Holotype, U. S. N. M. 92066; paratype, 92066*a*.

CTENOCEPHALUS EXCAVATUS Resser, n. sp.
Plate 7, figures 14, 15

A single cranidium stands out very strongly as a distinct species, in fact the question of a distinct genus is raised, because the rim is apparently lacking.

C. excavatus differs radically from its associate, *C. howelli*, in depression in-

stead of elevation of the cheek lobes, so that even their slightly elevated portions lie below the level of the elevated rim; in the non-development of the eyelines; and in the surface markings—a very fine set of granules, so fine that the test appears almost smooth, overlain by a sparse, widely scattered set of large granules.

Occurrence same as preceding.

Holotype.—U. S. N. M. 92067.

Ctenocephalus angelini Resser, n. sp.
Plate 7, figures 9, 10

Among the specimens collected for the U. S. National Museum from the Andrarum limestone of Sweden in 1900 by Schmalensee, is a single cephalon not included among the described species of that prolific fauna. It was identified by the collector as *Elyx laticeps*, now *Ctenocephalus laticeps*, which it resembles.

C. angelina differs from *C. laticeps* in the more forward position of the anterior angles of the cephalon and in the consequent straightness of the front margin and quadrate shape of the cephalon (in fact the front margin is indented at the middle); in the surface markings, which consist of a rather evenly distributed set of fine granules instead of the lines of *C. laticeps*, with the coarse granules also more prominent than on any specimen of *C. laticeps* in hand.

Middle Cambrian, Andrarum limestone; (loc. 8*w*) Andrarum, Skåne, Sweden.

Holotype.—U. S. N. M. 92068.

Genus Holocephalina Salter, 1864

Holocephalina americana Resser, n. sp.
Plate 7, figures 1–4

A fairly common species of *Holocephalina*, formerly identified in the Manuels shale as *Hartshillia inflata* Hicks and in the limestone nodules as *Holocephalina teres* Grönwall, is here named *Holocephalina americana*. This trilobite cannot belong to *Hartshillia* because it has no heavy neck spine and because the glabella tapers forward. On the other hand *H. americana* resembles both the genotype *H. primordialis* Salter, and *H. teres* Grönwall. It differs from the latter in lacking the surface lines and in its shorter glabella. Fewer differences separate *H. americana* from *H. primordialis*, as both have a granulated surface of about the same pattern, but *H. americana* appears to have a shorter glabella and relatively greater width, though it is possible that the poor figures of *H. primordialis* available for comparison are misleading.

Middle Cambrian, Manuels; (loc. 1) Manuels Brook, Conception Bay, Newfoundland.

Types.—Holotype, U. S. N. M. 92069; paratypes, 92069*a–c;* unfigured paratypes, 92069*d–g*.

REFERENCE

1. C. E. Resser, Second contribution to nomenclature of Cambrian trilobites: *Smithsonian Misc. Coll.*, vol. 95, no. 4, pp. 1–29, 1936.

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ELKANAH BILLINGS' LOWER CAMBRIAN TRILOBITES AND ASSOCIATED SPECIES

CHARLES E. RESSER
U. S. National Museum, Washington, D. C.

ABSTRACT

Confusion has resulted from misidentification of Billings' Lower Cambrian trilobite species from Labrador and Vermont. A restudy of the type specimens and of specimens referred to the species by Walcott leads to considerable revision of the nomenclature. Twenty-five species are dealt with; 11 species are more sharply defined, and 2 new genera and 14 new species are instituted. Photographic illustrations of many of the forms are provided for the first time.

Elkanah Billings (1) in 1861 described seven species of Lower Cambrian trilobites from Labrador and Vermont, and he had in 1860 illustrated a pygidium from the St. Lawrence valley. Subsequently Walcott identified all of the species in his own collections and added others to the list. In 1897, Matthew (2) restudied Billings' types and described a new variety.

Recent studies of Appalachian fossils by the writer that required investigation of these species showed that Walcott's identifications are all erroneous, and that corrections are necessary also in Matthew's conclusions. Several of the necessary nomenclatural changes have been published, and the remainder are herewith discussed. The genus *Billingsaspis* Resser, recently published, must be suppressed because Billings' *Conocephalites vulcanus* and Walcott's identification of it were assumed to apply to the same trilobite, which is not the case (3).

Last year the Canadian Geological Survey, at the request of Dr. E. M. Kindle, kindly lent the writer Billings' types of *Bonnia*, and recently this organization also lent Billings' other types. Owing to the fact that none of Billings' types and few of the specimens identified by Walcott were ever photographed, it is thought desirable to present such illustrations of the material. Billings evidently did little preparatory work on his fossils, preferring to describe them by inference of what was hidden by the matrix. Matthew did somewhat better, but the full extent of many specimens is now revealed for the first time.

Generic assignments are made as closely as possible, but many of the forms belong to genera not easily distinguished. It may be said that they represent the median trilobite form, and they therefore present so many generalized features that the characters of one genus frequently approach those of another to such an extent that arbitrary separations must be made between them.

List of species dealt with in this paper

Labrador:

Bonnia parvula (Billings) (p. 45)
Bonnia matthewi Resser (p. 45)
Bonnia westoni Resser, n. sp. (p. 46)
(*parvula* Billings, part)

Bonnia billingsi Resser, n. sp. (p. 46) (*parvula* Billings, part)
Bonnia richardsoni Resser, n. sp. (p. 46) (*parvula* Billings, part)
Bonnia senecta (Billings) (p. 46)
Labradoria misera (Billings) (p. 47)
Labradoria elongata Resser, n. sp. (p. 48) (*miser* Billings, part)

Vermont:

Ptychoparella adamsi (Billings) (p. 49)
Ptychoparella billingsi Resser, n. sp. (p. 49) (*arenosus* Billings, part)
Ptychoparella vulcana (Billings) (p. 50)
Ptychoparella teucer (Billings) (p. 50)
Ptychoparella kindlei Resser, n. sp. (p. 50) (*teucer* Billings, part)
Kootenia ellsi (Walcott) (p. 50)
Perimetopus arenosus (Billings) Resser, n. gen. (p. 51)
Perimetopus secundus Resser, n. sp. (p. 51) (*arenosus* Billings, part)

Walcott's specimens referred to Billing's species:

Ptychoparella walcotti Resser, n. sp. (p. 52) (*adamsi* Walcott, part)
Ptychoparella swantonensis Resser, n. sp. (p. 52) (*adamsi* Walcott, part)
Ptychoparella vermontensis Resser, n. sp. (p. 52) (*adamsi* Walcott, part)
Ptychoparella georgiensis Resser, n. sp. (p. 52) (*adamsi* Walcott, part)
Periomma typicalis Resser, n. gen. and sp. (p. 53) (*vulcana* Walcott, part)
Bonnia swantonensis Resser (p. 53) (*senecta* Walcott, part)
Bonnia vermontensis Resser (p. 54) (*senecta* Walcott, part)
Antagmus typicalis Resser, n. sp. (p. 54) (*teucer* Walcott, part)
Antagmus? simplex Resser, n. sp. (p. 54) (*vulcana* Walcott, part)

SPECIES FROM LABRADOR

Billings referred to the genera then in use two species from Labrador now placed in *Bonnia* and one now placed in *Labradoria*. As pointed out below, one species is preserved in a brown granular limestone resembling, and mistaken for, a sandstone. The remainder are in the typical pinkish crystalline limestone that forms the bulk of the somewhat variable and chiefly archaeocyathid-reef limestone of the Forteau formation. Strangely enough, none of Billings' forms have yet been located among the numerous specimens in the U. S. National Museum's collections from the same beds and presumably from the same or nearby localities. However, it is possible that when the hundreds of specimens on hand are more carefully studied, forms to match Billings' species will be found.

Genus BONNIA Walcott, 1916

Corynexochus (*Bonnia*) WALCOTT, *1916*, Smithson. Misc. Coll., vol. 64, no. 5, p. 325.
Bonnia RAYMOND, *1928*, Am. Jour. Sci., 5th ser., vol. 15, no. 88, p. 309.—RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 6.

As recently pointed out, *Bonnia* was proposed as a subgenus of *Corynexochus* Angelin, but it is doubtful that the two genera are in the same family. Walcott made *Bathyurus parvulus* Billings the genotype but based his description on specimens from Bonne Bay, that represent several considerably different species. Unfortunately Billings' type specimens were not marked by him, and consequently in this case it is not possible to go back beyond Matthew's paper of 1897, except to distinguish between the specimens available in 1861 and those collected in 1872 by T. C. Weston.

Diagnosis: Small trilobites characterized by a long and essentially quadrate glabella; glabella usually quadrate, but sometimes expanded, occupying the entire length of the cranidium; glabellar furrows usually very faint; brim confined to a narrow cancave rim; fixed cheeks about equal to width of glabella; eyes rather large, somewhat forward of a middle position, eye lines present; free cheeks small, generally with short genal spines. Pygidium about the same size as cranidium; segments fused; pleural furrows usually well defined; axis usually arched above pleural lobes; one to three marginal spines at anterior angles.

Genotype: *Bathyurus parvulus* Billings.

Range: Lower Cambrian, North America and Asia.

BONNIA PARVULA (Billings)

Plate 8, figures 1–4

Bathyurus parvulus BILLINGS, *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 16, fig. 21.

Bathyurus senectus BILLINGS (part), *1861*, idem, fig. 20 (fig. 19 = *Bonnia senecta*).

Bathyurus senectus MATTHEW (part), *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 196, pl. 4, fig. 4*b* (figs. 4, 4*a* = *Bonnia senecta*).

Dorypyge parvula angifrons MATTHEW, *1897*, idem, p. 197, pl. 4, figs. 6, 6*a*.

Bonnia parvula RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 7.

Not *Doropyge parvula* MATTHEW, *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 197.

Bonnia parvula must be based on specimens from Labrador available to Matthew in 1897. Inasmuch as *Dorypyge parvula* Matthew (not Billings) and Matthew's variety *D. p. angifrons* are quite distinct species, an effort was made for economy's sake, to retain both names, but since both Billings' specific name and Matthew's varietal name are clearly based on the same specimen, they must be regarded as synonyms, and a new name must be given to Matthew's *D. parvula*. This conclusion is inescapable when the original labels are read, for they state that the specimen to which Matthew gave the varietal name was collected by Richardson in 1861, whereas the other specimens later identified by Billings and figured by Matthew as *D. parvula* were collected by T. C. Weston in 1872. Naturally, Billings' name must be restricted to the fossils he had available when he described his species in 1861. Moreover, application of a drop of acid to the matrix of Billings' holotype causes it to effervesce freely, showing that it is a limestone and that its brown, fine-grained appearance misled Matthew into calling the rock a sandstone and in consequence suggesting Vermont as the possible locality. In fact, Richardson, the collector, was also misled by this appearance, for the original label reads "grey sandstone." All other specimens, including those underlying Walcott's identifications, previously referred to *B. parvula* represent new species.

As to the pygidium, Matthew describes none for this species, but both he and Billings figure a pygidium with *B. senecta*, that by its features matches the holotype cranidium of *B. parvula* and is contained in the same peculiar brown sandstone-like matrix.

B. parvula is characterized by its parallel-sided glabella and the absence of glabellar furrows—in short, by simplicity in all its features. Unfortunately both the head and tail are exfoliated specimens, hence individuals preserving the test should appear much smoother than the illustrations here given.

Lower Cambrian, Forteau; L'Anse au Loup, Labrador.

Types: Holotype, Nat. Mus. Canada 433; hypotype, 433*a*.

BONNIA MATTHEWI Resser

Plate 8, figures 5–8

Dorypyge parvula MATTHEW (not Billings), *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 197, pl. 4, figs. 5–5*c*.

Corynexochus (*Bonnia*) *parvulus* WALCOTT (part), *1916*, Smithson. Misc. Coll., vol. 64, no. 5, p. 328, pl. 57, figs. 1–1*c*.

Bonnia matthewi RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 8.

As explained in the discussion of *Bonnia parvula*, the specimens on which *B. matthewi* is based came into the collections in 1872 and were then identified with Billing's species of 1861. Matthew's description of *Dorypyge parvula* is based on this head and tail, not on Billing's original type.

In comparisons with *B. parvula* this species is much wider. The glabella expands slightly forward, and the rim is both flatter and wider. The associated pygidium is very distinct in its broad rim, the reduction of the pleural ribs to narrow sloping ridges, and the larger marginal spines. Above all, the presence of lines on all elevated portions of the test serves to distinguish the species from others present in Labrador.

Occurrence same as preceding.
Syntypes: Nat. Mus. Canada 427, 433*g*.

BONNIA WESTONI Resser, n. sp.
Plate 8, figures 9–11

A single incomplete cranidium associated with the types of *B. parvula*, is similar to *B. matthewi*. It differs in the more evenly rectangular glabella, the shorter head, and the narrower fixed cheeks. In addition, the irregular surface lines are more evenly distributed and extend onto the fixed cheeks.

Occurrence same as preceding.
Holotype: Nat. Mus. Canada 433*c*.

BONNIA BILLINGSI Resser, n. sp.
Plate 8, figures 12–15

This species is similar to *B. westoni*, differing in its slightly expanding and

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EXPLANATION OF PLATE 8

FIGS. *1–4—Bonnia parvula* (Billings). *1, 2*, Dorsal and side views, ×2, of the holotype cranidium. *3, 4*, Similar views, ×2, of the pygidium referred to the species. (p. 45)
5–8—Bonnia matthewi Resser. *5, 6*, Dorsal and side views, ×2, of the holotype; *7*, an enlarged portion, ×4, to show surface lines. *8*, An associated pygidium assigned to the species, ×2. (p. 45)
9–11—Bonnia westoni Resser, n. sp. *9, 10*, Dorsal and side views, ×2, of the holotype cranidium; *11*, enlarged portion showing surface lines, ×4. (p. 46)
12–15—Bonnia billingsi Resser, n. sp. *12, 13*, Dorsal and side views, ×2, of the holotype cranidium. *14, 15*, Similar views, ×2, of the associated pygidium. (p. 46)
16–19—Bonnia richardsoni Resser, n. sp. *16, 17*, The holotype cranidium, ×2; *18*, the surface lines, ×4. *19*, Another smaller cranidium. (p. 47)
20–22—Bonnia senecta (Billings). *20, 21*, Dorsal and side views, ×2; *22*, surface features, ×4, of glabella of the neohololotype. (p. 47)
23–27—Labradoria misera (Billings). *23, 24*, Dorsal and side views, ×2, of the holotype; *25*, dorsal view, ×4. *26, 27*, A smaller, less complete cranidium, ×2. (p. 47)
28–30—Labradoria elongata Resser, n. sp., the holotype cranidium, ×2 and ×4. (p. 48)
31–33—Ptychoparella adamsi (Billings), the holotype cranidium, ×2 and ×1. (p. 49)
34–37—Ptychoparella billingsi Resser, n. sp. *34–36*, The holotype cranidium, ×2 and ×1; *37*, part of surface, ×4. (p. 49)
38, 39—Ptychoparella vulcana (Billings), dorsal views, ×2 and ×1, of the holotype cranidium. (p. 50)
40, 41—Ptychoparella kindlei Resser, n. sp., Dorsal views, ×1 and ×2, of the holotype. (p. 50)
42, 43—Ptychoparella teucer (Billings), Billings' holotype, ×2 and ×1. (p. 50)
44—Ptychoparella georgiensis Resser, n. sp., view, ×1, of plaster cast of the specimen in the Museum of Comparative Zoology. (p. 52)
45, 46—Ptychoparella swantonensis, Resser, n. sp., dorsal and side views, ×1, of the holotype. (p. 52)
47, 48—Ptychoparella walcotti Resser, n. sp., holotype cranidium, ×1. (p. 52)
49—Perimetopus secundus Resser, n. sp., holotype cranidium, ×1. (p. 51)
50, 51—Perimetopus arenosus (Billings), holotype cranidium, ×1. (p. 51)
52, 53, 65—Ptychoparella vermontensis Resser, n. sp. *52, 53*, Views, ×1 and ×2, of a better preserved cranidium. *65*, Walcott's specimen of *Ptychoparia adamsi*, the holotype, ×1. (p. 52)
54, 55—Antagmus? simplex Resser, n. sp., syntypes; *54*, the cranidium figured by Walcott, ×2; *55*, another cranidium, ×1, showing median swelling. (p. 54)
56–58—Periomma typicalis Resser, n. sp. *56*, Squeeze of a specimen showing the eye, ×1. *57*, A larger cranidium, ×1. *58*, Walcott's type of *Ptychoparia vulcana*, the holotype, ×1. (p. 53)
60, 61—Bonnia vermontensis Resser, cranidium and associated pygidium, ×2. (p. 54)
59, 62, 63—Bonnia swantonensis Resser, a large cranidium, a smaller cranidium, and a pygidium, ×2. (p. 53)
64—Antagmus typicalis Resser, n. sp., Walcott's type of *Ptychoparia teucer*, the holotype, ×1. (p. 54)
The localities are as follows: *1–30*. Forteau; L'Anse au Loup, Labrador. *31–33, 38–39*, and possibly *34–37*. Winooski; 1 mile east of Highgate Springs, Vermont. *40–32, 57–63*. Parker; 1½ miles east of Swanton, Vermont. *44*. Parker; Parkers Quarry, Georgia, Vermont. *45–48*. Mallet; 2 miles east of Swanton, Vermont. *52–55, 64, 65*. Parker or Winooski; 1 mile east of Highgate Springs, Vermont.

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longitudinally more convex glabella. It is also similar to *B. parvula* from which it differs in the more rounded anterior outline of its glabella and the angularity of the anterior margin. An associated pygidium, in the same kind of rock, is placed with the species. This, too, is much like *B. parvula*, differing in the greater prominence of the furrows.

Occurrence same as preceding.

Types: Holotypes, Nat. Mus. Canada 433*b;* paratype, 433*f*.

BONNIA RICHARDSONI Resser, n. sp.
Plate 8, figures 16–19

Two cranidia among the specimens labelled *B. parvula* are distinguished by the rounded outline of the anterior fourth of the glabella and the strength of the irregular surface lines.

Occurrence same as preceding.

Types: Holotype, Nat. Mus. Canada 433*d;* paratype, 433*e*.

BONNIA SENECTA (Billings)
Plate 8, figures 20–22

Bathyurus senectus BILLINGS (part), *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 15, fig. 19.
Bathyurus senectus MATTHEW (part), *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 196, pl. 4, figs. 4, 4*a*.
Bonnia senecta RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 8.

Billings' description and illustration are inadequate to identify the species. Matthew subsequently restudied the type, preserved at Ottawa, concluding that it is not the holotype but a specimen substituted by Billings for it. However, since the figures of both authors clearly indicate a form with expanding glabella, the species must rest on Matthew's neoholotype. Specimens from many localities identified as *B. senecta* belong to other species.

B. senecta is at once distinguished from the other species in Labrador by its long, expanding glabella, the rather strong glabellar furrows, and the rounded frontal outline of both glabella and cranidium. Surface lined on glabella, granulated on fixed cheeks.

Occurrence same as preceding.

Neoholotype: Nat. Mus. Canada 420.

Genus LABRADORIA Resser, 1936

Labradoria RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 25.

The diagnosis of *Labradoria* was written from the descriptions and drawings published by several authors, but now that Billings' specimens are available several modifications are necessary. As stated by Matthew, three specimens in the collections of the National Museum of Canada were identified as *Conocephalites miser* Billings. Of these two are alike, one evidently being the neoholotype of Walcott. Matthew noted the manner in which the third specimen differs but did not rename it.

Diagnosis: Glabella large, convex in both directions, occupying nearly the entire length of the cranidium, extending forward almost to the rim; a strong occipital furrow marking off a neck ring, which extends into a stout spine; three sets of glabellar furrows present, one or two pairs in the rear joined across the middle; eyes situated about the middle of the cranidium; wide but not sharply delimited eyelines present; palpebral lobes thickened and elevated, separated from the fixed cheeks by a rather strong furrow; brim consisting chiefly of a thickened rim but in the type species has a narrow preglabellar area; sutures diverge slightly anterior to the eyes; surface granulose.

Genotype: *Conocephalites miser* Billings.

LABRADORIA MISERA (Billings)
Plate 8, figures 23–27

Conocephalites miser BILLINGS, *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 11, fig. 14.—MATTHEW, *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 200, pl. 4, figs. 7, 7*a*.
Ptychoparia miser WALCOTT, *1886*, U. S. Geol. Survey, Bull. 30, p. 199, pl. 27, fig. 2.
Labradoria miser RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 25.

Billings illustrated only a glabella, hence it is not clear whether one of the three available specimens is the original type subsequently prepared, or whether

Billings substituted another specimen for it.

Photographic illustrations are now presented for the first time and they show wherein previously published drawings are misleading. The characteristic granulose surface was never mentioned.

Lower Cambrian, Forteau; L'Anse au Loup, Labrador.

Types: Neoholotype, Nat. Mus. Canada 430*b;* paratype, 430.

LABRADORIA ELONGATA Resser, n. sp.
Plate 8, figures 28–30

Matthew noted that one of the three specimens preserved as the types of Billings' *Conocephalites miser* shows differences from the other two. He stated:

> It is a quarter longer than the others, has more deeply cut furrows, and of these the middle pair are scarcely connected.

To this should be added the absence of a preglabellar area, the more quadrate anterior outline of the glabella, the wider rim, particularly toward the anterior angles, and the more tumid palpebral lobes.

Occurrence same as preceding.

Holotype: Nat. Mus. Canada 430*a*.

SPECIES FROM VERMONT

The four species Billings described from Vermont offer several difficult problems. First, the stratigraphy is uncertain. When Billings described the species, geologists recognized a "Red sandrock" and a slate; subsequently Walcott disregarded stratigraphy entirely and threw together all the material in the U. S. National Museum from each locality as if but one formation were represented. As pointed out below, four formations are recognized today, but which yielded Billings' species is not in every case clear.

Second, widely divergent forms were identified as Billings' species, and the prevailing concept of a given form was changed to that of a trilobite totally different from the original. Careful sorting according to lithology has finally suggested an identification of each of the four original species and has permitted a tentative stratigraphic assignment for each of them.

The Lower Cambrian formations now recognized in northwestern Vermont begin with the Monkton quartzite, from which no fossils are known. This is followed by the calcareous Winooski and Mallet, two formations evidently containing approximately the same fauna. Finally, the Parker formation, consisting of shale and impure limestone, concludes the Lower Cambrian series. In this region the shale formations contain calcareous lenses, reefs, or beds, and the dolomitic and marble formations seemingly also have such reefs or lenses of limestone, as well as quartzitic and other clastic layers. In addition, the beds are severely folded, and consequently have suffered alteration, with accompanying distortion of the fossils. Taking all these factors together, it is readily understood that the stratigraphic position of the fossils is not to be determined in the laboratory alone.

Three of Billings' four Vermont species, *Conocephalites adamsi*, *C. vulcanus*, and *C. arenosus*, are in a purple quartzite, partly quite fine-grained, from a locality one mile east of Highgate Springs. Lithologically the rock is most like Monkton quartzite, but no Monkton crops out within many miles of this locality. B. F. Howell (4) regards this purple quartzite as most likely part of the Winooski formation, because it grades up into typical Winooski. These species are therefore listed tentatively as from this formation.

The trilobites under discussion belong to a very difficult group, which explains their previous reference to *Ptychoparia*. Final generic assignments cannot be made now, but careful comparisons warrant recognition of several genera among the species concerned. Poulsen established *Kochiella* and *Inglefieldia*, which

in their revised state care for a large and important group of Lower Cambrian forms, none of which is involved in our present study except by way of comparison. Poulsen also described *Ptychoparella*, and subsequently *Proliostracus*, two genera that may be identical, though examination of the specimens is necessary before the question can be definitely decided. However, the illustrations seem to show that both are valid. *Poulsenia* and *Antagmus* Resser, and several other genera, were recently published. *Ptychoparella*, *Poulsenia*, and *Proliostracus* are quite close to each other, but seem to be distinct. These genera include many species in the Lower Cambrian of both the Appalachian and the Cordilleran regions.

Genus PTYCHOPARELLA Poulsen, 1927

Ptychoparella POULSEN, *1927*, Medd. Grønland, vol. 70, p. 279.

Billingsaspis RESSER (part), *1935*, Smithson. Misc. Coll., vol. 93, no. 5, p. 16.

The type species was erroneously given a post-Cambrian stratigraphic position when described, because the lower Middle Cambrian fauna to which it belongs was yet unknown in the regions where Cambrian stratigraphy was then better understood.

Diagnosis: Cranidium wide; glabella two thirds or more as long as the cranidium, tapered, rounded in front by a clearly defined dorsal furrow; three pairs of reflexed glabellar furrows present; occipital furrow usually rather deep; fixed cheeks rather wide; sutures slightly divergent anterior to the eye; brim with rim of fairly even width, usually slightly thickened; preglabellar area always present and always exceeding the width of rim; eyes situated slightly back of the middle; eye lines well developed, arising slightly forward of the short anterior pair of glabellar furrows. Other parts uncertain.

Ptychoparella is distinguished from *Proliostracus* chiefly by its narrower and more even rim and by the lesser swelling of the mid preglabellar area. From *Poulsenia* it departs chiefly in the increased width of the preglabellar area, diversity in which feature causes the two genera to intergrade.

As indicated on page 43, *Billingsaspis* Resser, 1935, falls into the synonymy of *Ptychoparella*.

Genotype: *P. brevicauda* Poulsen

Range: Lower Cambrian and lower Middle Cambrian, North America.

PTYCHOPARELLA ADAMSI (Billings)

Plate 8, figures 31–33

Conocephalites adamsi BILLINGS, *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 12, fig. 15.

Ptychoparia adamsi MATTHEW (part), *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 199, pl. 4, fig. 9.

Ptychoparella adamsi RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 14.

There is no reason to doubt that the specimen here figured is Billings' type, refigured by Matthew. It has been cleaned so that most of it is now uncovered. As pointed out by Matthew none of the forms described by Walcott belong to this species, but Matthew's inclusion of *P. vulcanus* is also not warranted. *P. adamsi* occurs in purple quartzite, not sandy shale, as stated by Matthew. The matrix is too coarse to take fine detail but the fossil is better preserved than the average specimen from the locality. More than 25 specimens are contained in the National Museum collections, most of them poorly preserved.

Lower Cambrian, Winooski (?); (loc. 26) 1 mile east of Highgate Springs, Vermont.

Holotype: Nat. Mus. Canada 429.

PTYCHOPARELLA BILLINGSI Resser, n. sp.

Plate 8, figures 34–37

Conocephalites arenosus BILLINGS (part), *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 15.

This cranidium, preserving a portion of the granulose test on both the glabella and fixed cheek, is near *P. adamsi*, but differs in the much longer cranidium and the slightly more elevated glabella. The specimen is preserved in a dark-pink dolomite, and was in the same tray with

and identified as *Conocephalites arenosus*. It is hence supposed to have come from a locality near the international boundary, but the rock is typical Winooski and no outcrops of such beds are known so far north. Consequently the locality is more likely that east of Highgate Springs from which Billings' other material came.

Occurrence possibly same as preceding.

Holotype: Nat. Mus. Canada 502.

PTYCHOPARELLA VULCANA (Billings)
Plate 8, figures 38, 39

Conocephalites vulcanus BILLINGS, *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 14, fig. 17.

Billingsaspis vulcanus RESSER (part), *1935*, Smithson. Misc. Coll., vol. 93, no. 5, p. 16.

Matthew regarded the imperfect specimen on which Billings based this species as a distorted example of *P. adamsi*. None of the numerous specimens in this matrix is distorted, even though some appear to have been considerably decayed before fossilization. Three additional, but poor, examples are in the U. S. National Museum collections, showing conclusively that *P. vulcanus* is a good species.

The features that distinguish *P. vulcanus* from *P. adamsi* are greater width, due to wider fixed cheeks, and a wider preglabellar area.

Without examination of Walcott's material from the Parker formation, his identification of the species was assumed to be correct, and the genus *Billingsaspis* Resser was based on it. Though the concept of *Billingsaspis* was actually based on Walcott's *Ptychoparia vulcana*, because *Conocephalites vulcanus* Billings was named as the genotype, *Billingsaspis* falls into synonymy under *Ptychoparella*, and a new generic name must be given to *Ptychoparia vulcana* Walcott.

Occurrence same as *P. adamsi*.

Holotype: Nat. Mus. Canada 432.

PTYCHOPARELLA TEUCER (Billings)
Plate 8, figures 42, 43

Conocephalites teucer BILLINGS, *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 13, fig. 16.

Anomocare teucer MATTHEW, *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 198, pl. 4, fig. 8.

Walcott's identification of his specimens as Billings' *C. teucer* is erroneous; the material is from another bed. *P. teucer* proper occurs in micaceous shale and, therefore, evidently is from the Parker formation, younger than *P. adamsi* and its associated fauna.

At first sight *P. teucer* goes beyond the possible limits of the genus *Ptychoparella*, but further study seems to warrant its inclusion. The type specimen is squeezed and hence is deceptive, but Matthew's reconstrucion of it is too wide. It is like *P. vulcanus* in having a wide brim. Whether lateral compression accounts for all of the narrowing of the fixed cheek is not quite certain, but there can be no great difference between the two species. *P. teucer* has more prominently developed glabellar furrows than *P. vulcanus*, but the enclosing matrix would likely account for such a difference, even if both were originally alike.

Lower Cambrian, Parker; 1½ miles east of Swanton, Vermont.

Holotype: Nat. Mus. Canada. 431.

PTYCHOPARELLA KINDLEI Resser, n. sp.
Plate 8, figures 40, 41

A smaller cranidium associated with the holotype of *P. teucer* represents another species, named in recognition of the kind assistance of E. M. Kindle in lending Billings' types for this study.

The new species is shorter and narrower than *P. teucer*, and likely had less deeply impressed glabellar furrows.

Occurrence same as preceding.

Holotype: Nat. Mus. Canada 431*a*.

KOOTENIA ELLSI (Walcott)

Dikelocephalus sp., BILLINGS, *1860*, Canadian Nat., vol. 5, p. 313, text-fig.—*1865*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 405, fig. 384.

Olenoides ellsi WALCOTT (part), *1891*, U. S. Geol. Survey, 10th Ann. Rept., p. 642, text-figs. 66*a–e*.

Billings twice published the drawing of the tail referred to this species, as-

signing it to *Dikelocephalus* with reservation and questioning its stratigraphic position. No locality was given for Billings' specimen, that given below being the location of the syntypes of Walcott.

Lower Cambrian, boulder in Sillery; south shore of St. Lawrence, 4 miles below Quebec, Canada.

Genus PERIMETOPUS Resser, n. gen.

Three cranidia, clearly representing three species, were named *Conocephalites arenosus* by Billings. On a previous page one of these has been renamed *Ptychoparella billingsi*. A second is renamed below, and the third is regarded as *C. arenosus*. Walcott viewed *C. arenosus* as a variant form of *C. adamsi*, but a glance at the illustrations shows that they are not only distinct species but belong to different genera. The depth of the dorsal furrow attracted Matthew's attention and caused him to refer *C. arenosus* to *Solenopleura*.

Diagnosis: Cranidium alone known. Glabella clearly defined by the dorsal furrow, rounded in front, tapered; one rear pair of sharply flexed glabellar furrows faintly visible; occipital furrow strong; fixed cheeks of moderate width, rising to a ridge at the palpebral lobe; eyes evidently rather small, situated slightly behind the middle of the head; brim consists of a wide rim and very narrow preglabellar area; anterior furrow sharply impressed and about straight across the head.

Genotype: *Conocephalites arenosus* Billings.

Etymology: *περί*, concerning; *μέτωπον*, the forehead, front.

PERIMETOPUS ARENOSUS (Billings)
Plate 8, figures 50, 51

Conocephalites arenosus BILLINGS (part), *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 15, fig. 18.

Solenopleura arenosa MATTHEW, *1897*, Roy. Soc. Canada, Trans., 2d ser., vol. 3, sec. 4, p. 199, pl. 4, fig. 10.

As stated by Matthew, this species was poorly figured by Billings, but it will be observed from the photograph that Matthew's drawing is also inadequate. Billings states that this species occurs in "thin bedded, flaggy sandstone," whereas Matthew writes that the specimens are "casts or moulds in slate." As a matter of fact the rock is a dark-gray dolomitic limestone of the type common in the Lower Cambrian. Working with the needle indicates that no siliceous mineral grains are present. Unfortunately, as frequently happens in dolomite, the specimen is difficult to free from the matrix, owing to the lack of a layer of separation along the trilobite test. Somewhat more of the fossil is now visible, but the outer edges are not recoverable. No other collections containing this trilobite, nor with a similar dolomitic limestone matrix, are known and its stratigraphic position remains in doubt. This and the following species, together with *Ptychoparella billingsi*, are the only fossils assigned to the locality, which according to Billings' description would be in the Philipsburg series. However, the matrix of *P. billingsi* is a pink dolomite, different from that of the other species and suggestive of a horizon in the Winooski formation. If the two other species are of Lower Cambrian age, they must have come from somewhat east of the locality given and from strata now mapped as Mallet formation.

Only the one cranidium is known, and its features are shown by the illustrations.

Lower Cambrian, Mallet; near the international boundary, on road from St. Armand to Highgate Springs, Vermont.

Holotype: Nat. Mus. Canada 428*a*.

PERIMETOPUS SECUNDUS Resser, n. sp.
Plate 8, figure 49

Conocephalites arenosus BILLINGS (part), *1861*, Paleozoic Foss., vol. 1, Geol. Survey Canada, p. 15.

The second cranidium, associated with the type of *P. arenosus* but never illustrated, differs from that form in the wider glabella, but even more in the brim, where the rim is wider and the preglabellar area almost eliminated.

Occurrence same as preceding.

Holotype: Nat. Mus. Canada 428.

WALCOTT'S IDENTIFICATIONS OF BILLINGS' SPECIES

Mention has already been made of the fact that none of the forms identified by Walcott with Billings' species is the same. For the most part the supposedly identical species are from different formations, although from the same general region. How these errors are rectified is shown in the bibliographic references given with the individual species.

PTYCHOPARELLA WALCOTTI Resser, n. sp.
Plate 8, figures 47, 48

Ptychoparia adamsi WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 195, pl. 26, fig. 1*b*.—*1891*, idem, 10th Ann. Rept., p. 649, pl. 96, fig. 1*b*.

Not *Conocephalites adamsi* BILLINGS, *1861* (see this paper, p. 49).

Walcott figured a narrow and a wide form from the limestone "lentile" east of Swanton. This rock is likely the gray Mallet limestone characteristically developed at this locality. Besides trilobites, the rock contains many thick-shelled *Kutorgina*. Since the fossils are not oriented on bedding-planes, and since the limestone is largely composed of irregular flat sheets that are evidently archaeocyathid, the material has the characteristics of a reef. Billings apparently had no specimens from this bed.

More than 10 specimens of the "broad form" and 8 of the "narrow form" remain in the U. S. National Museum collections, and since there is no appreciable distortion of the fossils and no intergradation between the two forms, each constitutes a valid species. The name *Ptychoparella walcotti* is applied to the broad form.

Lower Cambrian, Mallet; (loc. 25*a*) 2 miles east of Swanton, Vermont.

Holotype: U. S. Nat. Mus. 65008.

PTYCHOPARELLA SWANTONENSIS Resser, n. sp.
Plate 8, figures 45, 46

Ptychoparia adamsi WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 195, pl. 26, fig. 1*a*.—*1891*, idem, 10th Ann. Rept., p. 649, pl. 96, fig. 1*a*.

Not *Conocephalites adamsi* BILLINGS, *1861* (see this paper, p. 49).

Eight specimens of the "narrow form" constitute a species that differs from *P. walcotti*, in addition to its narrowness, in its greater convexity in both directions.

Occurrence same as preceding.

Holotype: U. S. Nat. Mus. 65007.

PTYCHOPARELLA VERMONTENSIS Resser, n. sp.
Plate 8, figures 52, 53, 65

Ptychoparia adamsi WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 195, pl. 26, fig. *1*.—*1891*, idem, 10th Ann. Rept., p. 649, pl. 96, fig. 1.

Not *Conocephalites adamsi* BILLINGS, *1861* (see this paper, p. 49).

The specimen illustrated by Walcott's figure 1 occurs in a sandy residue, evidently a leached dolomite. Its age is uncertain; it is tentatively regarded as from one of the dolomite lenses about the middle of the Parker formation, though it may have come from the Winooski or Mallet formations. *P. vermontensis* is wider than *P. walcotti*, and differs from both *P. walcotti* and *P. swantonensis* in its relatively narrower and more tapering glabella and in its narrower rim.

Lower Cambrian, Parker or Winooski; (loc. 26) 1 mile east of Highgate Springs, Vermont.

Holotype: U. S. Nat. Mus. 55005.

PTYCHOPARELLA GEORGIENSIS Resser, n. sp.
Plate 8, figure 44

Ptychoparia adamsi WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 195, p. 26, fig. 1*c*.—*1891*, idem, 10th Ann. Rept., p. 649, pl. 96, fig. 1*c*.

Not *Conocephalites adamsi* BILLINGS, *1861* (see this paper, p. 49).

Several incomplete but articulated specimens of *Ptychoparella* have been collected from the *Olenellus* zone of the Parker shale. Walcott figures the one preserved in the Museum of Comparative Zoology, Cambridge, Massachusetts, as *P. adamsi*. Unfortunately the cranidium is not well preserved and the published drawing is incorrect, though other specimens indicate the presence of a fairly wide preglabellar area. *P. georgiensis* has narrower fixed cheeks than those of *P. adamsi*, which makes the glabella relatively wider.

Lower Cambrian, Parker; (loc. 25) Parker Quarry, Georgia, Vermont.

Holotype: Mus. Comp. Zoology; cast, U. S. Nat. Mus. 65009.

Genus PERIOMMA Resser, n. gen.

Billingsaspis RESSER (part), *1935*, Smithson. Misc. Coll., vol. 93, no. 5, p. 16.

It is necessary to reconsider this genus because in 1935 the identity of *Ptychoparia vulcana* Walcott with *Conocephalites vulcanus* Billings was not questioned. A restudy of Billings' material shows clearly that there is no relationship between the form he described and that which Walcott subsequently identified with it. Inasmuch as the genotype for *Billingsaspis* was given as *Conocephalites vulcanus* Billings, which is a *Ptychoparella*, *Billingsaspis* becomes untenable.

As the original description of *Billingsaspis* was based entirely on Walcott's *Ptychoparia vulcana* from Vermont, and related species in Pennsylvania, a new generic name may be substituted without change in the original description. However, according to the rules the specific name of Walcott's form must also be changed.

Diagnosis: Small trilobites with conical glabella occupying little more than half of the length of the head; three pairs of reflexed glabellar furrows faintly impressed; occipital furrow deep; brim with a thickened rim; preglabellar area slightly wider than rim; both rim and preglabellar area are apt to be arched in the middle; fixed cheeks wide; eye lines heavy; eyes small, situated about the middle of the head; palpebral lobes elevated, which with the cheeks rising to them and the heavy eye lines, make the eye position prominent.

Genotype: *Periomma typicalis* Resser (*Ptychoparia vulcana* Walcott, not Billings).

Etymology: *περί*, Concerning; *ὄμμα*, the eye.

Lower Range: Possibly confined to the Cambrian of North America, but may extend into slightly younger beds.

PERIOMMA TYPICALIS Resser, n. sp.

Plate 8, figures 56–58

Ptychoparia vulcanus WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 198, pl. 26, fig. 4.—*1891*, idem, 10th Ann. Rept., p. 653, pl. 96, fig. 4.

Crepicephalus vulcanus MILLER, *1889*, North Am. Geol. Pal., p. 540.

Acrocephalites? vulcanus WALCOTT, *1916*, Smithson. Misc. Coll., vol. 64, no. 3, p. 182, pl. 26, fig. 2.

Billingsaspis vulcanus RESSER, *1935*, Smithson. Misc. Coll., vol. 93, no. 5, p. 16.

Not *Conocephalites vulcanus* BILLINGS, *1861* (see this paper, p. 50).

This species is restricted to the form in shale from the locality near Swanton, Vermont. Two additional cranidia are illustrated besides Walcott's chief specimen, to show different pressure aspects and the eye lobe.

Two locality numbers appear on the specimens of this species. The rock is a shaly material, originally limy and in places quite arenaceous. Part of the material is labeled "25," or Parker's Quarry, but the correct locality is thought to be that given below. Associated with *P. typicalis* are the several species of *Bonnia*.

Lower Cambrian, Parker; (loc. 28) south of Highgate Falls, east of Swanton, Vermont.

Holotype and paratypes: U. S. Nat. Mus. 15437.

BONNIA SWANTONENSIS Resser

Plate 8, figures 59, 62, 63

Protypus senectus WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 213, pl. 31, fig. 2.—*1891*, idem, 10th Ann. Rept., p. 655, pl. 98, fig. 7.

Corynexochus capito WALCOTT (part), *1916*, Smithson. Misc. Coll., vol. 64, no. 5, p. 315, pl. 57, fig. *2b–c*.

Bonnia swantonensis RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 11.

Bonnia lata RESSER, *1936*, idem, p. 11.

More accurate photographs show no essential difference between *B. swantonensis* and the cranidium called *B. lata*. The latter name may be dropped.

As will be seen from the illustrations, little resemblance exists between *B. swantonensis* and *B. senecta*, with which Walcott identified it. Owing to its simplicity there is more similarity with *B. matthewi*, with which species comparisons are therefore made. The Vermont species is somewhat larger and its glabella expands slightly more. None of the speci-

mens preserve the test, and comparisons of surface features is not possible.

Occurrence same as preceding.

Types: Holotype, U. S. Nat. Mus. 15421*b*; paratypes, 15421*a*.

BONNIA VERMONTENSIS Resser
Plate 8, figures 60, 61

Protypus senectus WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 213, pl. 31, figs. 2*a–c*.—*1891*, idem, 10th Ann. Rept., p. 655, pl. 98, figs. 7*a–c*.

Corynexochus capito WALCOTT (part), *1916*, Smithson. Misc. Coll., vol. 64, no. 5, p. 315, pl. 57, figs. 2*d,e*.

Bonnia vermontensis RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 11.

It is likely that Walcott had this species in mind when he identified *B. senecta* in Vermont. It is long and in other respects much like *B. senecta*, but without better preserved material exact comparisons cannot be made. The associated pygidium evidently had the pleural grooves not completely effaced by fusion.

Occurrence same as preceding.

Syntypes: U. S. Nat. Mus. 15421*c*, *d*.

Genus ANTAGMUS Resser, 1936

ANTAGMUS TYPICALIS Resser, n. sp.
Plate 8, figure 64

Ptychoparia teucer WALCOTT, *1886*, U. S. Geol. Survey, Bull. 30, p. 197, pl. 26, fig. 3.—*1891*, idem, 10th Ann. Rept., p. 652, pl. 96, fig. 3.

Antagmus teucer RESSER, *1936*, Smithson. Misc. Coll., vol. 95, no. 4, p. 4.

Not *Conocephalites teucer* BILLINGS, *1861* (see this paper, p. 00).

Evidently the rules require a change in specific name in this instance, because the species *teucer* Billings belongs to a different trilobite than that which Walcott regarded as the same. Since this is the type of the genus, *typicalis* seems appropriate.

Lower Cambrian, Parker or Winooski; (loc. 26) 1 mile east of Highgate Springs, Vermont.

Holotype: U. S. Nat. Mus. 15436.

ANTAGMUS? SIMPLEX Resser, n. sp.
Plate 8, figures 54, 55

Ptychoparia vulcanus WALCOTT (part), *1886*, U. S. Geol. Survey, Bull. 30, p. 198, pl. 26, fig. 4*a*.—*1891*, idem, 10th Ann. Rept., p. 653, pl. 96, fig. 4*a*.

Not *Conocephalites vulcanus* BILLINGS, *1861* (see this paper, p. 50).

An incorrect drawing of this specimen was published in 1886 and reprinted in 1891, and assigned to *P. vulcanus*. By comparison with nearby figures on the present plate it will be observed that no relationship exists between this and *C. vulcanus* Billings or *Periomma typicalis*, as Walcott's *Ptychoparia vulcana* is now called.

Little likeness to *A. typicalis* is at first apparent, but careful study seems to show generic affinities. The type of *A. typicalis* is more convex, which gives the rim a different aspect. In *A.? simplex*, which is smaller in size, the glabella is more squarely truncated and the cheeks are a little broader.

Occurrence same as preceding.

Syntypes: U. S. Nat. Mus. 65006.

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A DIMINUTIVE FAUNA FROM THE SHAKOPEE DOLOMITE (ORDOVICIAN) AT CANNON FALLS, MINNESOTA

CLINTON R. STAUFFER
University of Minnesota, Minneapolis, Minnesota

ABSTRACT

In some localities much of the Shakopee dolomite is cherty. Where the chert is oolitic, it disintegrates readily and has been found to contain numerous specimens of a diminutive molluscan fauna, quite different from any thus far reported from the formation. This fauna contains 10 gastropods, 3 cephalopods, and a trilobite. Eight gastropods are new, as are the 3 cephalopods. The fauna is of Beekmantown aspect and supports the usual correlation of the Shakopee.

In the Shakopee dolomite at Cannon Falls, Minnesota, 45 to 50 feet below the base of the St. Peter sandstone, there commonly occur masses of white oolitic chert which are much weathered and chalky in appearance. A careful examination of the resulting loose material has revealed numerous small fossils, most of which belong to the Mollusca. These were first discovered and collected by Dr. Thomas S. Lovering a number of years ago. Since that time other collections have been made from the same locality, and the present paper is a study of the species that have been found to constitute the fauna.

The fossils are all of small size, there being not even a fragment of what might be considered a large individual. It may therefore be said to be a diminutive or depauperate fauna, whose individuals may have existed elsewhere in more normal size. Except for the silicification of these nodules it is probable that no trace of the fauna would have been preserved in this region. Much of the material is not well preserved, as it is, but this is probably due to weathering of a comparatively recent date. The fossils are chiefly internal molds, but occasionally fragments of the shell still cling to them; or partial external molds may be preserved, thus partly revealing surface characters.

Specimens of most of the species are rather common, and the fauna is of great importance not because of the fine specimens which it contains but for its correlation possibilities. This latter is somewhat impaired by the small size of the individuals and by the fact that their equivalents may not as yet have been discovered in the deposits of Shakopee age in other regions. At least one species appears to be the same as one described by Whitfield from the Fort Cassin beds, and another one seems to be identical with a species from the Calciferous of eastern Canada described by Billings. Still other fragmentary specimens, of less certain identity, may belong to *Cyrtoceras confertissimum* Whitfield and *Cyclostomiceras minimum* (Whitfield). All members of the fauna belong to genera common in the Fort Cassin beds, and some of those regarded as

new resemble very closely certain described species from that horizon. In fact, the whole assemblage is so strongly suggestive of the Beekmantown that it must be considered a distinctly Canadian fauna and therefore supports the usual correlation of the Shakopee dolomite.

SYSTEMATIC DESCRIPTIONS

ARCHINACELLA SIMPLEX (Billings)
Plate 10, figures 1, 2

Metoptoma simplex BILLINGS, *1865*, Geol. Survey Canada, Paleozoic Foss., vol. 1, p. 346, fig. 334.

Tryblidium simplex WHITEAVES, *1886*, Am. Mus. Nat. Hist., Bull., vol. 1, pp. 306–307, pl. 24, figs. 30, 31.

Archinacella simplex ULRICH and SCOFIELD, *1897*, Geol. Minnesota, vol. 3, pt. 2, p. 826.

This species checks with the figures and descriptions by Billings and Whiteaves in every way except size and is regarded as a diminutive of the form so described.

Hypotype: Geol. Mus. Univ. Minnesota 4857.

Horizon and locality.—In the oolitic chert of the Shakopee dolomite at Cannon Falls.

CERATOPEA PYGMAEA Stauffer, n. sp.
Plate 9, figures 3, 9, 10

A liberty-cap-shaped operculum with a hollowed-out, transversely oval base. The apex of the cap rises to a height about equal to the greatest diameter of the base, is pointed, and twisted or curved to the outer or more convex side. The inner side is slightly flattened, and a sharp keel running backward from the apex separates these two sides. This feature doubtless marks the margin of the contact of the operculum with the shell aperture. Coarse growth lines cover the whole surface, paralleling the margin of the base or attachment pit.

This is a very abundant fossil in the oolitic cherty masses of the Shakopee. It may belong to one of the species of *Raphistoma* that are also abundant in these same masses, but this cannot as yet be proven.

Syntypes: Geol. Mus. Univ. Minnesota 4848, 4854, 4855.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Connon Falls.

ECCYLIOMPHALUS TRANSVERSO-CORDATUS Stauffer, n. sp.
Plate 10, figures 7, 11, 12

Shell small, slightly coiled, the whorls decreasing in curvature as they gradually expand towards the aperture, the last part nearly straight. Cross-section of the last whorl rounded, heart-shaped, slightly flattened or depressed on the inner side

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EXPLANATION OF PLATE 9

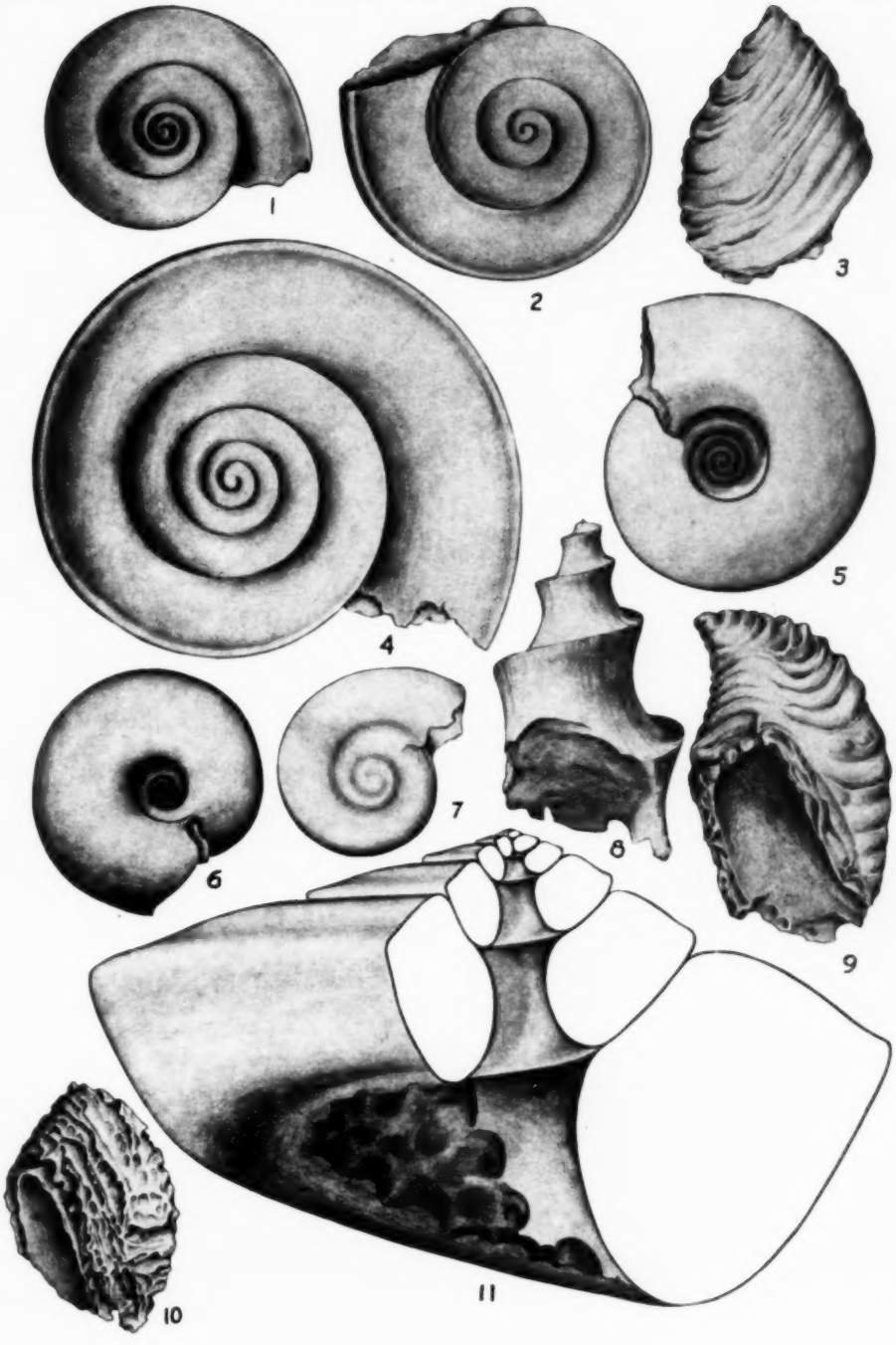
All figures ×10; all specimens from Shakopee dolomite at Cannon Falls, Minnesota

FIGS. *1, 2, 5—Raphistoma parvum* Stauffer, n. sp., syntypes; *1*, a small specimen with rather narrow whorls; *2*, apical view of a specimen showing the sub-marginal depression on the surface; *5*, umbilical view showing greatest width and all coils exposed. (p. 58)

3, 9, 10—Ceratopea pygmaea Stauffer, n. sp., syntypes; *3*, outer surface of a fine specimen; *9*, a fine large specimen showing the concavity of the attachment pit; *10*, a specimen with partially weathered surface. (p. 56)

4, 6, 8, 11—Raphistoma shakopeënse Stauffer, n. sp., syntypes; *4*, apical view of a typical specimen; *6*, umbilical view of a small specimen, showing narrow opening and great depth; *8*, mold of the umbilicus showing the growth-lines; *11*, an unusually large specimen, with portion removed to show section of the coils and the umbilical filling. (p. 59)

7—Euomphalopsis depressa Stauffer, n. sp., holotype, specimen showing partial preservation of the shell. (p. 57)



Stauffer, Canadian Gastropods

UNIV. OF MICH.

or impressed zone, and acute, with apical notch, on the outer or peripheral margin. The surface is marked by growth lines which cross the impressed zone in a nearly straight line, then sweep backward with a curvature which increases as it approaches the periphery, where a deep notch with a grooved band exists.

This species resembles *E. compressus* Whitfield but differs from that form in its slender, gradually expanding whorls, its heart-shaped cross-section, and its distinct peripheral band.

Syntypes: Geol. Mus. Univ. Minnesota 4862, 4866.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

EUOMPHALOPSIS DEPRESSA Stauffer, n. sp.
Plate 9, figure 7

Shell a small flattened coil, with the apical angle almost reduced to a straight angle. Whorls in contact, suture poorly defined, peripheral margin plain, rounded. Umbilicus broad, very shallow. A few poorly defined growth lines seem to show indistinctly, suggesting a flattened transversely oval aperture.

Holotype: Geol. Mus. Univ. Minnesota 4852.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

HORMOTOMA CANNONENSIS Stauffer, n. sp.
Plate 10, figure 3

Shell with medium high spire, the apical angle of which is about 20°. Probably six or more whorls with rounded outer surface, with a well developed peripheral band on about the middle of each whorl. Suture deep where the shell is removed from the internal mold but poorly defined where the shell is partially preserved. The surface markings are not retained by the specimen obtained. Aperture probably oval, with notched outer and calloused inner lip.

This specimen resembles and may be one of the species included by Billings under *Hormotoma anna* (Billings) (1), but it is certainly distinct from the type of that species (2).

Holotype: Geol. Mus. Univ. Minnesota 4858.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

HORMOTOMA CASSINA (Whitfield)
Plate 10, figures 6, 10

Murchisonia cassina WHITFIELD, *1897*, Am. Mus. Nat. Hist., Bull. 9, p. 179, pl. 4, fig. 7.

Shell slender, moderately high spired, apical angle about 32°. Probably five, six, or more whorls in a complete specimen. These have a well defined peripheral band, above and below which the whorls are rounded. Suture deeply impressed. Growth lines poorly defined on the specimens as preserved but apparently showing slight curvature into peripheral band. Aperture large, oval and probably entire except for the peripheral notch. Callus poorly developed.

Hypotypes: Geol. Mus. Univ. Minnesota 4861, 4865.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

LOPHOSPIRA PERELEGANS Stauffer, n. sp.
Plate 10, figures 5, 8, 14, 15

Shell consisting of five or six whorls neatly coiled into a spire with an apical angle of about 65°. Each whorl with a strongly developed peripheral ridge with band, above and below which there is a slightly defined secondary ridge showing on some specimens. The growth lines poorly preserved but sweep backward into the peripheral ridge in such manner as to suggest that the siphonal slit was little more than a notch. The circularity of the aperture is interrupted only along the outer margin where the peripheral and secondary ridges are developed. Umbilicus almost completely closed by callosity. The restoration of aperture problematical.

Syntypes: Geol. Mus. Univ. Minnesota 4860, 4863, 4868, 4869.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

LOPHOSPIRA VETUSTA Stauffer, n. sp.
Plate 10, figures 4, 9

Spire consisting of about five or six whorls and forming an apical angle of about 45°. Whorls angular, peripheral ridge pronounced, its sides meeting in an obtuse angle. Less pronounced ridges occur above and below the periphery at about equal distances, the lower one being the stronger. Aperture suggested but not fully known. It is apparently definitely notched at the outer margin and shows little additional detail. Surface markings not preserved.

Syntypes: Geol. Mus. Univ. Minnesota 4859, 4864.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

RAPHISTOMA PARVUM Stauffer, n. sp.
Plate 9, figures 1, 2, 5

Shell consisting of four or five, possibly more, whorls which form a very low or flat spire with an apical angle of 170° to 180°. In some specimens, near the end of the last whorl preserved and doubtless near the aperture, the whole upper surface may rise slightly above that of the preceeding whorl. The upper surfaces of volutions generally convex, the concavity near the outer margin very poorly developed, thus forming a very shallow groove parallel to the peripheral keel, the latter being about on level with the suture. Outer surface of whorl slightly convex, but the under surface rounded, with its greatest convexity immediately below the suture. Growth lines poorly preserved, but they appear to swing very slightly into the keel. Umbilicus open, extending to top of spire. Peripheral notch poorly developed.

EXPLANATION OF PLATE 10

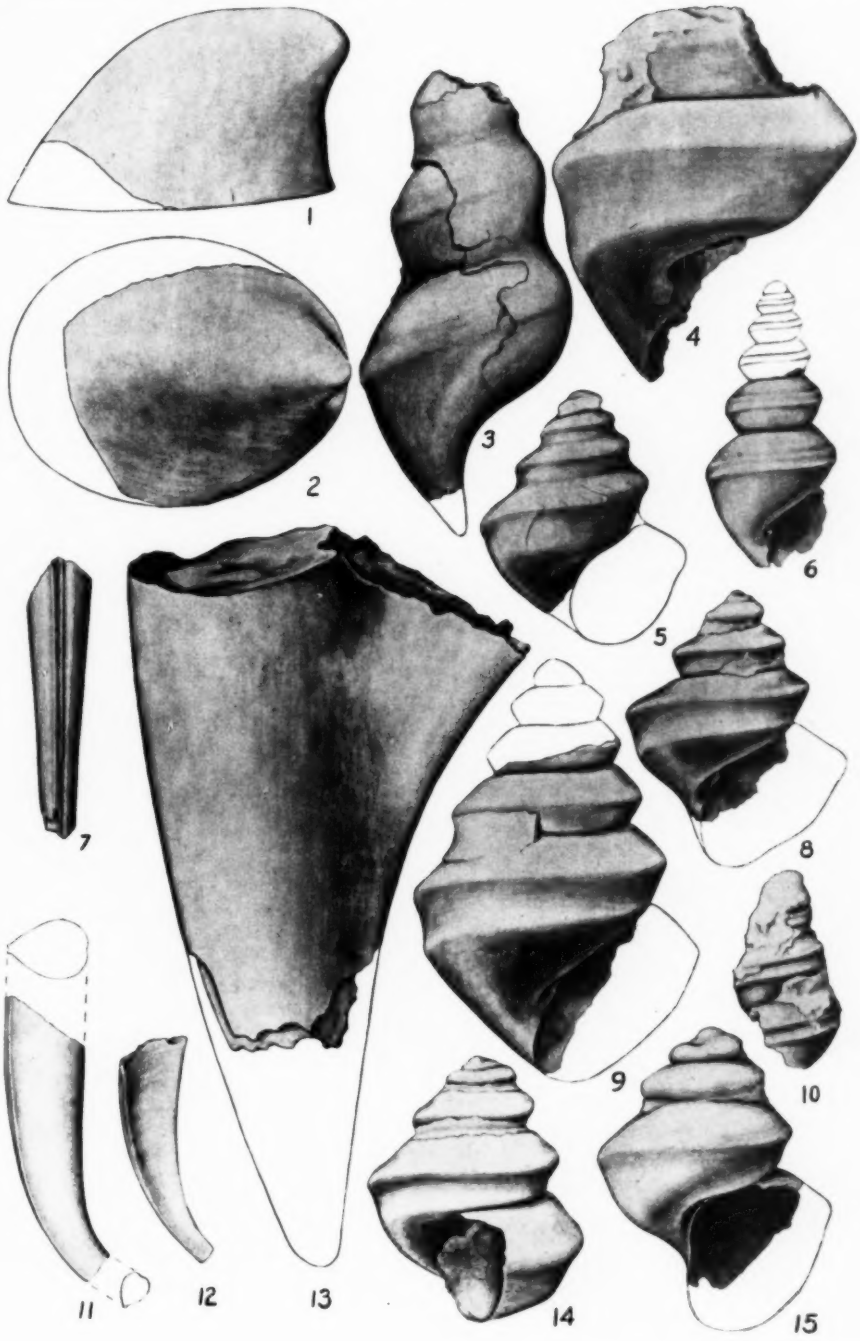
All figures ×10; all specimens from Shakopee dolomite at Cannon Falls, Minnesota

FIGS. *1, 2—Archinacella simplex* (Billings), hypotype, an internal mold. (p. 56)
3—Hormotoma cannonensis Stauffer, n. sp., holotype, internal mold with part of shell. (p. 57)
4, 9—Lophospira vetusta Stauffer, n. sp., syntypes; *4*, fragment of a comparatively large individual; *9*, specimen showing the general characters. (p. 58)
5, 8, 14, 15—Lophospira perelegans Stauffer, n. sp., syntypes; *5*, an almost complete specimen showing some of the growth lines; *8*, an internal mold; *14, 15*, internal molds with part of shell. (p. 57)
6, 10—Hormotoma cassina (Whitfield), hypotypes; *6*, specimen showing the general characters of the species; *10*, fragment showing well-developed band. (p. 57)
7, 11, 12—Eccyliomphalus transverso-cordatus Stauffer, n. sp., syntypes; *7*, specimen with pronounced peripheral band; *11*, same, showing top view and cross-sections; *12*, specimen showing growth lines. (p. 56)
13—Trilobite, portion of a large free-cheek. (p. 60)

EXPLANATION OF PLATE 11

All figures ×10; all specimens from the Shakopee dolomite at Cannon Falls, Minnesota

FIGS. *1, 3—Cameroceras inopinatum* Stauffer, n. sp., syntypes; *1*, fragment showing several chambers; *3*, specimen showing the broad ventral saddle and the marginal siphuncle. (p. 59)
2, 4, 5, 7—Orygoceras eburneolum Stauffer, n. sp., syntypes; *2*, small fragment showing several chambers and the sub-marginal siphuncle; *4*, fragment apparently showing the living chamber, one camera, and the sub-marginal siphuncle; *5*, another fragment; *7*, a specimen showing some of the growth-lines. (p. 59)
6—Deltoceras tantillum Stauffer, n. sp., holotype, a fragmentary specimen showing subventral siphuncle. (p. 59)
8—Trilobite, fragment of a free-cheek. (p. 60)



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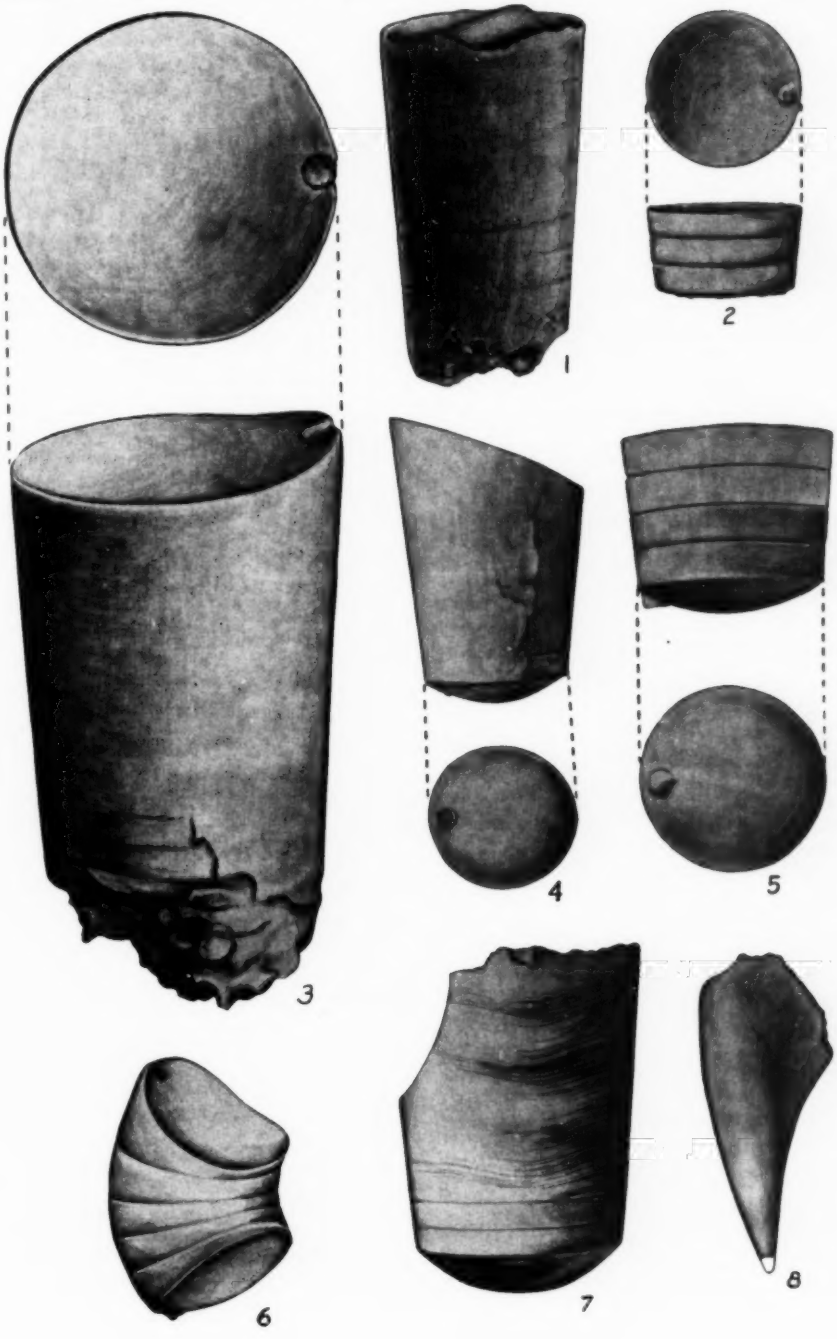

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Syntypes: Geol. Mus. Univ. Minnesota 4846, 4847, 4850.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

RAPHISTOMA SHAKOPEËNSE Stauffer, n. sp.
Plate 9, figures 4, 6, 8, 11

Shell consisting of five or six, possibly more, whorls rising into a low spire with an apical angle of about 150°. Upper surface of volutions slightly convex, with a narrow concavity near the outer margin. Peripheral keel sharply rounded, outer surface slightly convex, under surface of whorl very rounded convex. The cross-section of the whorl concave along the inner side where it lies against the preceding whorl. Umbilicus narrow, deep. Whorls increase in cross-section by two and one-half with each turn. They are marked by strongly developed growth lines which swing gently backward towards the peripheral keel, cross it, then apparently sweep forward in the same manner on the outer side. On the inner side they are not parallel to the axis of the spire but incline forward at an angle of about 20°.

This species resembles *Raphistoma minnesotense* Owen but differs in its apical angle, more rapidly expanding whorls, narrower and deeper umbilicus, and swing of the growth lines.

Syntypes: Geol. Mus. Univ. Minnesota 4849, 4851, 4853, 4856.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

CAMEROCERAS INOPINATUM Stauffer, n. sp.
Plate 11, figures 1, 3

Small orthoceracones with conch expanding at the rate of about 1 mm. in 8 to 10 mm., circular in cross-section. Camerae numerous, shallow, convexity of septae a little less than twice the depth of camerae; siphuncle small, circular, and subventran in position. Suture simple except for a broad ventral siphuncular saddle without lateral lobes. Surface probably smooth except for growth lines, which are very poorly preserved.

Syntypes: Geol. Mus. Univ. Minnesota 4870, 4872.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

DELTOCERAS TANTILLUM Stauffer, n. sp.
Plate 11, figure 6

This fragmentary specimen doubtless belongs to this genus rather than to any of the other gyroceracones more or less common at this general horizon. In the portion preserved the volutions were apparently in contact, but there is no evidence of an impressed zone. Cross-section subcircular, with the dorso-ventral diameter the greater. Camerae uniform, shallow; suture shows a broad but scarcely perceptible ventral saddle. Siphuncle small and propioventran in position. Living chamber and surface unknown.

Holotype: Geol. Mus. Univ. Minnesota 4875.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

ORYGOCERAS EBURNEOLUM Stauffer, n. sp.
Plate 11, figures 2, 4, 5, 7

Small orthoceracones with circular cross-section or, if depressed, scarcely perceptible as such. Shell increasing in diameter about 1 mm. in 5 mm. Camerae numerous; concavity of septae being about one and one-half times the distance between septae or depth of camerae. Suture simple, siphuncle small, and propioventran in position. Surface probably smooth except for numerous growth lines which dip slightly apicad on the venter. The surfaces of some internal molds show very slight annular rings or thickenings which suggest *O. cornu-onyx* (Whitfield) although the Shakopee species does not seem to agree with the figures and description of that form.

Syntypes: Geol. Mus. Univ. Minnesota 4871, 4873, 4874, 4876.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

Trilobite, undetermined

Plate 10, figure 13; Plate 11, figure 8

Fragments of the genal spines of trilobites are rather common in this fauna. The fragments are all indeterminate but may belong to *Entomaspis* or some related genus.

Figured specimens: Geol. Mus. Univ. Minnesota 4867, 4877.

Horizon and locality.—In the oolitic cherts of the Shakopee dolomite at Cannon Falls.

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MOLLUSCA FROM THE SHAKOPEE DOLOMITE (ORDOVICIAN) AT STILLWATER, MINNESOTA

CLINTON R. STAUFFER
University of Minnesota, Minneapolis, Minnesota

ABSTRACT

In the Shakopee dolomite at Stillwater, Minnesota, about 45 feet above the Oneota or 105 feet above the top of the Jordan sandstone, a very important assemblage of fossils includes 11 species, of which two are new; a fucoid, five gastropods, and five cephalopods. The fauna is markedly similar to that found in the Fort Cassin beds of the Lake Champlain region, to the Cotter of Missouri and to other faunas of similar age in various parts of North America.

The composition and constitution of the Shakopee dolomite varies much from place to place. Thus in the Twin City region of Minnesota the lower portion of the formation is quite sandy and may have beds of sandstone interbedded with the dolomites. This condition is even more pronounced at Burkhardt Mills and New Richmond, Wisconsin, where these sandstones are interbedded with layers of dolomite carrying Shakopee fossils (1), whereas in northern Illinois (2) the Shakopee formation contains much shale and sandstone. In southern Minnesota, at the critical horizon between the Oneota and Shakopee dolomites, there is a 30 to 40 foot bed of sandstone which increases in importance to the southward and continues into Iowa (3). It is this sandstone that usually has been referred to by both the Minnesota and the Iowa Geological Surveys as the New Richmond sandstone (4). It appears to mark the true boundry between these two formations, although beds of sand may also be found within the Oneota dolomite.

Cryptozoon reefs are common in the Shakopee formation and may be either thick lenticular masses which grade off laterally into beds of brecciated cryptozoon fragments or wide spread algal beds of relatively uniform thickness. The associated shaly beds may show well-developed mud cracks with sand filling, and occasionally even ripple-marks appear among these local evidences of shallow water deposition. Over large areas the Shakopee appears as a massive gray to drab dolomite not unlike that of the usual Oneota, and this is very confusing especially when the characteristic faunas of either formation cannot be located readily. More often, however, the thinner bedded Shakopee is really a dolomitic limestone which may be highly oolitic in the lower part of the formation and may contain large masses of oolitic chert, some of which have been found to contain a diminutive fauna (see pp. 55–60).

The marked difference between the Oneota and Shakopee faunas inindicates a long interval of time between these two formations. Dr. E.

O. Ulrich has made this disconformity the dividing line between his Ozarkian and Canadian systems, and there is much to be said in favor of his contention. Conglomerates sometimes occur at the contact, but more commonly the horizon is marked by the sandstones and sandy beds, referred to above, that have been called the New Richmond sandstone but which are more probably the basal phase of the Shakopee dolomite. Since, however, it is known that both the Oneota and the Shakopee dolomites are sandy and may contain beds of real sandstone, there is some difficulty in identifying the Oneota-Shakopee contact when fossils are absent—a sandy layer is no guarantee of the proper horizon at which to draw the dividing line between these two important formations.

The sections at Preston and Lanesboro, Fillmore County, Minnesota, may be regarded as typical of these formations in southern Minnesota, and the 30 to 40 feet of sandstone there represented separate the two formations. Although this sandstone may be the basal bed of the Shakopee or possibly the upper part of the Oneota, it has distinguishing lithological and mineralogical characteristics which make it easily identifiable all over southeastern Minnesota and as far north as Red Wing. Along the Mississippi River the highly fossiliferous cherts of the upper part of the Oneota lie immediately below this sandstone. In that part of the state all the dolomite below that sandstone, and above the Jordan sandstone is regarded as Oneota. However, attempts to identify this relatively thick sandstone bed with sandy horizons along the St. Croix and Minnesota Rivers or in the well logs of the Minneapolis-St. Paul Metropolitan area only leads to confusion and should be abandoned.

The outcrop at Stillwater.—At Stillwater, Minnesota, the outcrop begins with sandy dolomitic beds belonging to the St. Lawrence formation and extends upward through the Jordan sandstone and the Oneota dolomite to beds well up in the Shakopee dolomite. Sixty feet above the top of the Jordan sandstone Ulrich located a conglomerate which he regards as "the basal bed of the Shakopee dolomite" (5). Accepting this as the probable contact, there is still about 50 feet of dolomite partly exposed along the hillside in the southern part of the city of Stillwater together with some sandy dolomite near the top, all of which belongs to the Shakopee. At about 45 feet above the conglomerate, or about 105 feet above the Jordan-Oneota contact, rather massive layers of dolomite yielded many fossils from an excavation made during the laying of a water main at Dubuque and South Fifth Avenue during the summer of 1934. Although these specimens are poorly preserved and many of them fragmentary, those that can be identified add materially to the known Shakopee fauna. They appear to belong, for the most part, to species long known from other formations of similar age and are thus of much value for correlation purposes.

DESCRIPTIONS OF SPECIES

In the following pages, for the forms identified with known species only the reference to the original description is given. For synonymies see Bassler, R. S., Bibliographic index of American Ordovician and Silurian fossils: U. S. Nat. Mus. Bull. 92, vols. 1, 2, 1915.

PALAEOPHYCUS TUBULARE Hall?
Plate 12, figure 13

Palaeophycus tubularis HALL, *1847*, Paleont. New York, vol. 1, p. 7, pl. 2, figs. 1, 2, 4, 5.

Hypotype: Geol. Mus. Univ. Minnesota 4888.

Cylindrical stems of nearly uniform thickness, which branch at irregular intervals and are obscurely marked by longitudinal striae but otherwise smooth. Specimens presumably of this species form a mat which makes up a large part of a sandy dolomitic layer near the top of the outcrop. This layer, an inch or two in thickness, also contains *Hormotoma* sp., but lies just below the major part of the fauna discussed in this paper.

Horizon and locality.—In the Shakopee sandy dolomite, 42 feet above the base of the formation, at Stillwater, Minnesota.

HELCIONOPSIS sp.
Plate 12, figures 1, 2

Holotype: Geol. Mus. Univ. Minnesota 4878.

Shell medium to large, gibbous in the umbonal region. General outline subovate, the posterior rounded, the anterior slightly acuminate. Beak anterior, prominent, curving forward and slightly downward. Shell substance apparently not very thick and marked by well defined growth lines which are occasionally aggregated into lamellae.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

HORMOTOMA ARTEMESIA (Billings)
Plate 12, figures 3, 4

Murchisonia artemesia BILLINGS, *1865*, Geol. Survey Canada, Paleozoic Foss., vol. 1, p. 345, fig. 332.

Hypotypes: Geol. Mus. Univ. Minnesota 4879, 4880.

Shell slender, with an apical angle of 15° to 16°. Four to five whorls show on the specimens obtained but the apex is not preserved and neither is the entire body whorl present. Suture line deeply impressed. Whorls depressed convex on the outer surface (the drawing is probably somewhat in error in this respect), with a well developed revolving band showing on the periphery. Growth lines, faintly suggested on some specimens, strongly shown on others, curving backward into the band both above and below it. Largest whorl preserved is about 20 mm. across, and in the same specimen there are 5 whorls in a length of about 66 mm. The Shakopee specimens are all internal molds and the largest one sketched is somewhat flattened so that in drawing the original shape had to be restored.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

OPHILETA CANADENSIS (Billings)
Plate 12, figures 7–10, 12

Pleurotomaria canadensis BILLINGS, *1865*, Geol. Survey Canada, Paleozoic Foss., vol. 1, pp. 342–343.

Hypotypes: Geol. Mus. Univ. Minnesota 4883–4886.

Shell large, with depressed spire. Apical angle about 140°, but the upper surface of the last whorl (gerontic?) may be nearly in the same plane with the preceding, thus flattening the angle very much. Spire consisting of about six whorls. Umbilicus very large, open, showing the preceding whorls. Suture depressed. Peripheral margin acute, turned up, thus giving a slightly concave submarginal strip on the otherwise flattened-convex upper surface of the whorls; under surface of whorls very convex; impressed zone slightly concave. A few surface markings show growth lines swinging backward from the suture to

the periphery on the upper surface and forward from the same into the impressed zone on the under side. Largest specimen about 44 mm. in diameter.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

Ophileta sp.
Plate 12, figure 11

Hypotype: Geol. Mus. Univ. Minnesota 4887.

Numerous specimens of a comparatively small *Ophileta* or *Raphistoma* occur in this fauna. Some of them may belong to *O. complanata*, but the preservation does not seem to warrant a definite identification. Possibly some may belong to forms occurring so commonly in the oolitic cherts at Cannon Falls, Minnesota.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

Plethospira cassina (Whitfield)
Plate 12, figures 5, 6

Lophospira cassina Whitfield, *1886*, Am. Mus. Nat. Hist., Bull., vol. 1, 1881–1886, pp. 312–314, pl. 25, figs. 1–4.

Hypotypes: Geol. Mus. Univ. Minnesota 4881, 4882.

The specimens from the Shakopee dolomite differ but slightly from those figured by Whitfield and certainly fall within the allowable variation of his descriptions. None show the greatly expanded aperture of his largest specimen. The carina is very pronounced and the spire is probably not quite as high as those in the Fort Cassin beds. The Shakopee specimens are all internal molds, not very well preserved, but there is some suggestion of the surface markings. In addition to faint growth lines that recede or dip backward to the peripheral carina, there are faint traces of revolving striae.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

Cameroceras stillwaterense Stauffer, n. sp.
Plate 13, figure 10

Holotype: Geol. Mus. Univ. Minnesota 4893.

Orthoceracones of medium to small size. Specimen retaining part of the living chamber and 20 to 24 of the chambers immediately preceding it is 100 mm. long and expands at the rate of about 1 mm. in 15 mm. The distance between septae is slightly less than 2 mm., there being about 5 camerae in a distance of 9 mm. Curvature or depth of septae about equal to the thickness of five camerae (9 mm.). The section of the conch is elliptical or subcircular; siphuncle large, about two-fifths greatest

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Explanation of Plate 12

All figures ×1; all specimens from Shakopee dolomite at Stillwater, Minnesota

Figs. *1, 2*—*Helcionopsis* sp., lateral view showing growth lines and high beak, and anterior view of high beak. (p. 63)

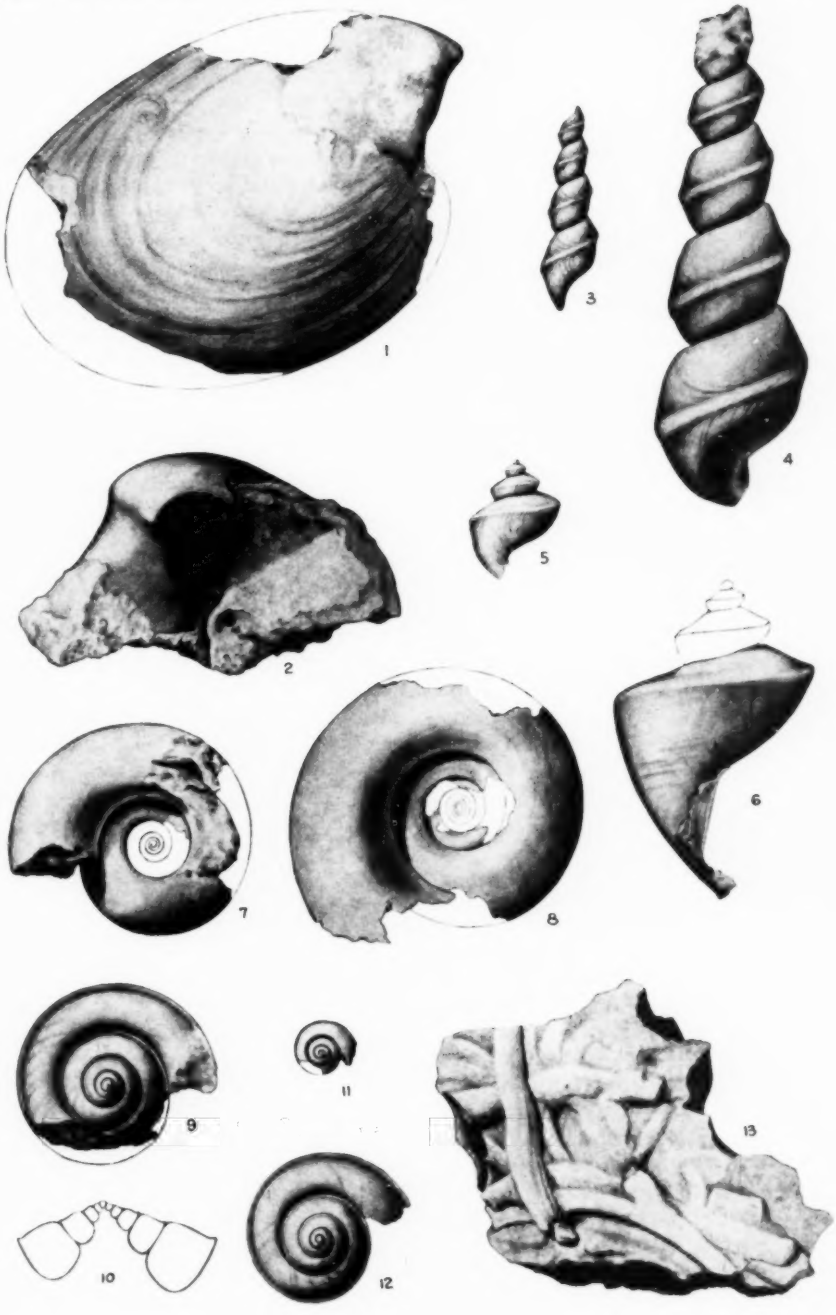
3, 4—*Hormotoma artemesia* (Billings); *3*, internal mold of a small specimen, or the apical end of a larger one, showing flattened whorls, growth lines and the slit band; *4*, internal mold of a rather large specimen showing the same features. (p. 63)

5, 6—*Plethospira cassina* (Whitfield); *5*, a small specimen showing growth lines; *6*, a medium sized specimen showing growth lines and traces of revolving striae. (p. 64)

7–10, 12—*Ophileta canadensis* (Billings); *7, 8*, two specimens showing wide, deep umbilicus; *9, 12*, apical views of two fairly well preserved specimens, showing growth lines and marginal carina; *10*, outline cross-section showing apical angle and high convexity of under side of whorls. (p. 63)

11—*Ophileta* sp., internal mold of one of the relatively numerous small specimens. (p. 64)

13—*Palaeophycus tubulare* Hall?, surface of a small rock fragment showing numerous interlaced specimens. (p. 63)



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cross-sectional diameter of conch; submarginal or propioventran in position; siphonal funnels probably slightly shorter than thickness of camerae; the matrix filling, or solid apical portion, of the endocone protruding apicad about 15 mm. beyond last chamber indicated. Fragment of living chamber 45 mm. long. Surface smooth except for indistinct remnants of growth lines.

Horizon and locality.—In Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

COTTEROCERAS COMPRESSUM
Ulrich and Foerste
Plate 13, figures 1–3

Cotteroceras compressum ULRICH and FOERSTE, *1935* (1936), Denison Univ. Bull., Jour. Sci. Lab., vol. 30, p. 270, pl. 38, fig. 10.

Hypotype: Geol. Mus. Univ. Minnesota 4889.

Straight orthoceracones with oval transverse section narrowest on the venter; conch tapering about 1 mm. in 10 mm. The relatively large siphuncle, which occupies nearly one third of the conch, subventran in position. Chambers numerous, about 30 in a length of 50 mm. Concavity of the septae equal to the depth of about two or two and one-half camerae. The suture line dips slightly on the venter to form a shallow ventral lobe. The specimen does not show surface or living chamber.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

CYPTENDOCERAS RUEDEMANNI
Ulrich and Foerste
Plate 13, figure 7

Cyptendoceras ruedemanni ULRICH and FOERSTE, *1935* (1936), Denison Univ., Bull., Jour. Sci. Lab., vol. 30, pp. 270–271, pl. 38, fig. 15.

Hypotype: Geol. Mus. Univ. Minnesota 4892.

Conch subcircular in cross-section, medium to small in size, straight, expanding at the rate of about 1 mm. in 8 mm. at the base of the living chamber or at a point where the specimen is 18 mm. average diameter. Total length of the conch was probably about 185 mm., estimated from the rate of expansion in specimens available. Septae closely spaced, about 6 of which occur in 8 mm. of length of conch. Septae moderately to very concave, the depth of concavity equal to about three and one-half camerae. Siphuncle not very clearly shown but about one-third the size of the conch, marginal, although apparently becoming submarginal (subventran) at the base of the living chamber. Suture line with a sharp ventral lobe over the siphuncle and a broad very shallow lobe on the dorsum; these two are separated by shallow lateral saddles. Surface smooth except for a few very obscure growth lines which suggest a slight ventral or hyponomic sinus. The narrow raised V-shaped object on the venter appears to have been entirely external and perhaps the attachment of some sedentary form to this individual as host. Other specimens, apparently of the same species, do not have it.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

ENDOCERAS CONSUETUM Sardeson?
Plate 13, figures 4–6

Endoceras consuetum SARDESON, *1896*, Minnesota Acad. Sci., Bull., vol. 4, p. 103, pl. 6, fig. 11.

Hypotypes: Geol. Mus. Univ. Minnesota 4890, 4891.

Orthoceracones of medium to small size. Conch expanding moderately, its rate of growth being about 1 in 15. Cross-section apparently circular or nearly so. Surface smooth or with fine growth lines. Camerae numerous, shallow, their depth about one-ninth of the width. Septae moderately concave or arching downward (apicad) about the depth of one and one-half to two camerae. Suture simple or bending slightly apicad on approaching the siphuncle, thus developing a shallow ventral lobe. Siphuncle marginal, circular, about one-third to one-half the cross-sectional diameter of the conch.

The specimens referred to this species do not seem to correspond exactly to Sardeson's figures and descriptions. However, they do appear to be the same as specimens from Pockett Station, Wisconsin, that are identified as *E. consuetum* Sardeson and which are nearly circular in cross-section.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

EURYSTOMITES KELLOGGI (Whitfield)
Plate 13, figures 8, 9, 11–13

Nautilus kelloggi WHITFIELD, *1886*, Am. Mus. Nat. Hist., Bull., vol. 1, p. 328, pl. 30, fig. 1.

Hypotypes: Geol. Mus. Univ. Minnesota 4895–4898.

Conch a closely coiled nautilicone through the ephebic stage, but during the gerontic stage changing to a lesser curvature with the living chamber separating from the earlier coils. The early volutions are subcircular in cross-section, becoming elliptical in ephebic, oval in gerontic stages. Dorsum has a very poorly defined impressed zone, becoming even less conspicuous on the free gerontic volution. Venter narrower than the dorsum, showing only slight flattening on the living chamber. A rather deep hyponomic sinus indicated by the growth lines on some specimens; the surface showing pronounced undulations at more or less regular intervals, these undulations tending to parallel the growth lines, although this tendency is not perfectly maintained. Camerae shallow, numerous. Suture lines crowded on the dorsum but more generously spaced on the venter, about twice as many per centimeter on the dorsum as on the venter at a point, on a small specimen, where the dorso-ventral dimension of the volution is 7 mm., about the middle of the ephebic stage. In all specimens which show the siphuncle it is rather small, not more than a sixth of the dorso-ventral dimension of the camera, subventran or propioventran in position.

There may be more than one species represented by the specimens from the Shakopee, but it is assumed that better material will show all of them to fall within the variation allowed by Whitfield's original descriptions, and by the further definitions by Hyatt and by Ruedemann.

Horizon and locality.—In the Shakopee dolomite, 45 feet above the base, at Stillwater, Minnesota.

FAUNAL LIST AND DISCUSSION

The known fauna from the Shakopee dolomite of Minnesota consti-

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EXPLANATION OF PLATE 13

All figures ×1; all specimens from Shakopee dolomite at Stillwater, Minnesota

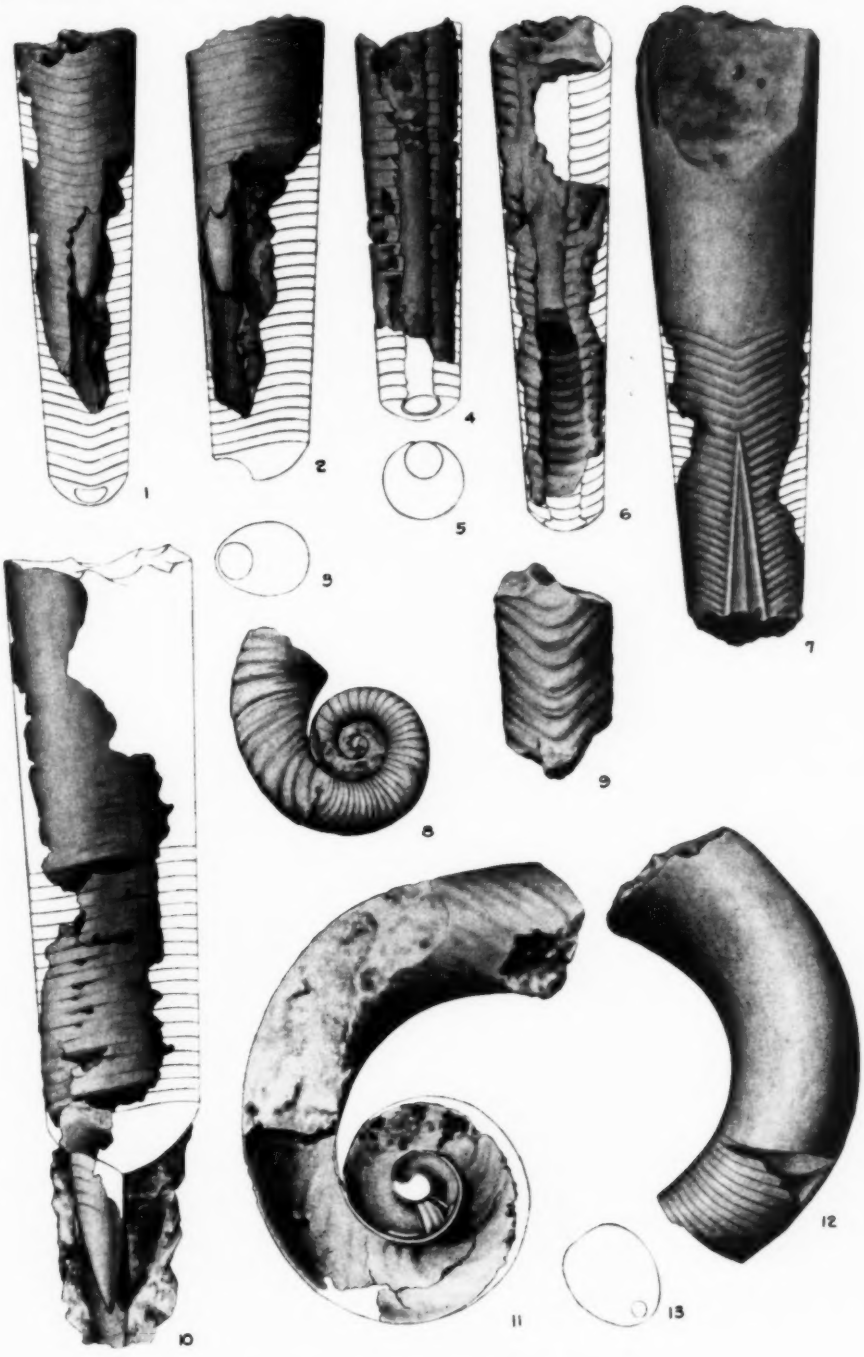
FIGS. *1–3*—*Cotteroceras compressum* Ulrich and Foerste; *1*, ventral view of specimen showing broad ventral lobe. *2*, lateral view showing sloping suture lines and large siphuncle. *3*, cross-section showing oval shape of conch and relatively large size of the siphuncle. (p. 65)

4–6—*Endoceras consuetum* Sardeson? *4*, *6*, two specimens showing regularity of suture and the siphuncle in contact with the shell; *5*, cross-section showing relative size of siphuncle. (p. 65)

7—*Cyptendoceras ruedemanni* Ulrich and Foerste, a specimen showing the sharp ventral saddle. (p. 65)

8, *9*, *11–13*—*Eurystomites kelloggi* (Whitfield); *8*, a small specimen showing sutures and part of exterior; *9*, a fragment showing the dip of the surface markings, which parallel the growth lines and hence show the hyponomic sinus; *11*, a small but almost complete specimen which is largely an external mold; *12*, a fragmentary specimen showing sutures and part of siphuncle; *13*, cross-section, showing shape and impressed zone; also the size and position of the siphuncle. (p. 66)

10—*Camaroceras stillwaterense* Stauffer, n. sp., lateral view of type specimen showing part of living chamber and great convexity of septae; the specimen is embedded in rock. (p. 64)



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tutes a list of 34 species. In the following table those marked with an asterisk (*) are from the cherts at Cannon Falls, Minnesota, and have been described on page 64.

List of Shakopee species

Cryptozoon giganteum Cheney
Cryptozoon minnesotense Winchell
Cryptozoon minnesotense l'bertale Winchell
Palaeophycus tubulare Hall
Crinoid or cystoid stems
**Archinacella simplex* (Billings)
**Ceratopea pygmaea* Stauffer
**Eccyliomphalus transverso-cordatus* Stauffer
**Euomphalopsis depressa* Stauffer
Helcionopsis sp.
Hormotoma artemesia (Billings)
**Hormotoma cannonensis* Stauffer
**Hormotoma cassina* (Whitfield)
**Lophospira perelegans* Stauffer
**Lophospira vetusta* Stauffer
Ophileta canadensis (Billings)
Ophileta sp.
Plethospira cassina (Whitfield)
**Raphistoma parvum* Stauffer
Raphistoma ruidum Sardeson
**Raphistoma shakopeënse* Stauffer
Subulites exactus Sardeson
Turritoma melaniformis (Shumard)
**Cameroceras inopinatum* Stauffer
Cameroceras stillwaterense Stauffer
Cotteroceras compressum Ulrich and Foerste
Cyptendoceras ruedemanni Ulrich and Foerste
Cyclostomoceras minimum (Whitfield)?
Cyrtoceras confertissimum Whitfield?
**Deltoceras tantillum* Stauffer
Endoceras consuetum Sardeson?
Eurystomites kelloggi (Whitfield)
**Orygoceras eburneolum* Stauffer
*Trilobite fragments

Fragmentary specimens of other species occur with those herewith listed but they have not been referred to genera or species. It is quite probable that the above list will be much increased as additional material is uncovered. Revisions, too, will be made as better specimens are found, but the material available is sufficient to confirm the relationships that have been suggested from the meager collections known. The marked resemblance to the fauna of the Fort Cassin beds of the Lake Champlain district seems evident. Some characteristic Fort Cassin species, or very similar forms, are also found in the Shakopee of Minnesota, and others appear to be closely related. Parts of the same fauna occur in the Calciferous of eastern Canada, southward through the Beekmantown of New York and the Newala limestone of Alabama (6), apparently to be picked up again in formations of similar age in Texas (7). Certain of the Shakopee species appear to occur in the Canadian formations of Arkansas and Missouri, and some of them are probably identical with species found in the Cotter (8). Unfortunately too little on the Cotter fauna has been published to develop the confidence that the correlation undoubtedly deserves. Josiah Bridge says that, "The Oneota fauna is very definitely the fauna of the Gasconade of Missouri, with many species in common. The fauna of the Shakopee is just as definitely the Cotter of Missouri" (9). This correlation evidently represents the conclusions of Ulrich, for he continues further, "I am fully convinced that Mr. Ulrich's interpretation of the two faunas and his correlation of them with those of the Missouri section is correct." The faunal evidence supplied by this paper supports the general conclusions of Ulrich and it is quite prob-

able that the Shakopee is the northward continuation of the Cotter.

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JOURNAL OF PALEONTOLOGY, VOL. 11, NO. 1, PP. 69–72, 3 TEXT-FIGS., JANUARY, 1937

AN APTIAN HORIZON IN THE CRETACEOUS OF THE LOWER MACKENZIE VALLEY

P. S. WARREN
University of Alberta, Edmonton, Alberta, Canada

ABSTRACT

Species of *Beudanticeras* and *Deshayesites* from the lower Mackenzie valley indicate the presence of Aptian (Lower Cretaceous) marine deposits there.

Rocks of Cretaceous age in the lower Mackenzie valley have been known since McConnell described certain outcrops in 1890 (1). The probable occurrence of such rocks however, was noted by Meek in 1859 in the description of two ammonites from this area, though he could not make a definite assertion as to their age (2). Since McConnell's time, Cretaceous rocks have been reported by various geologists in the lower Mackenzie basin; a good summary of our knowledge of these strata, together with a bibliography, has been given by Camsell and Malcolm in 1921 (3); and still further data have been secured through investigations by Hume and Williams (4), though their work, so far as the Cretaceous strata were concerned, was largely of a reconnaissance nature and apparently no detailed examination of these rocks was attempted.

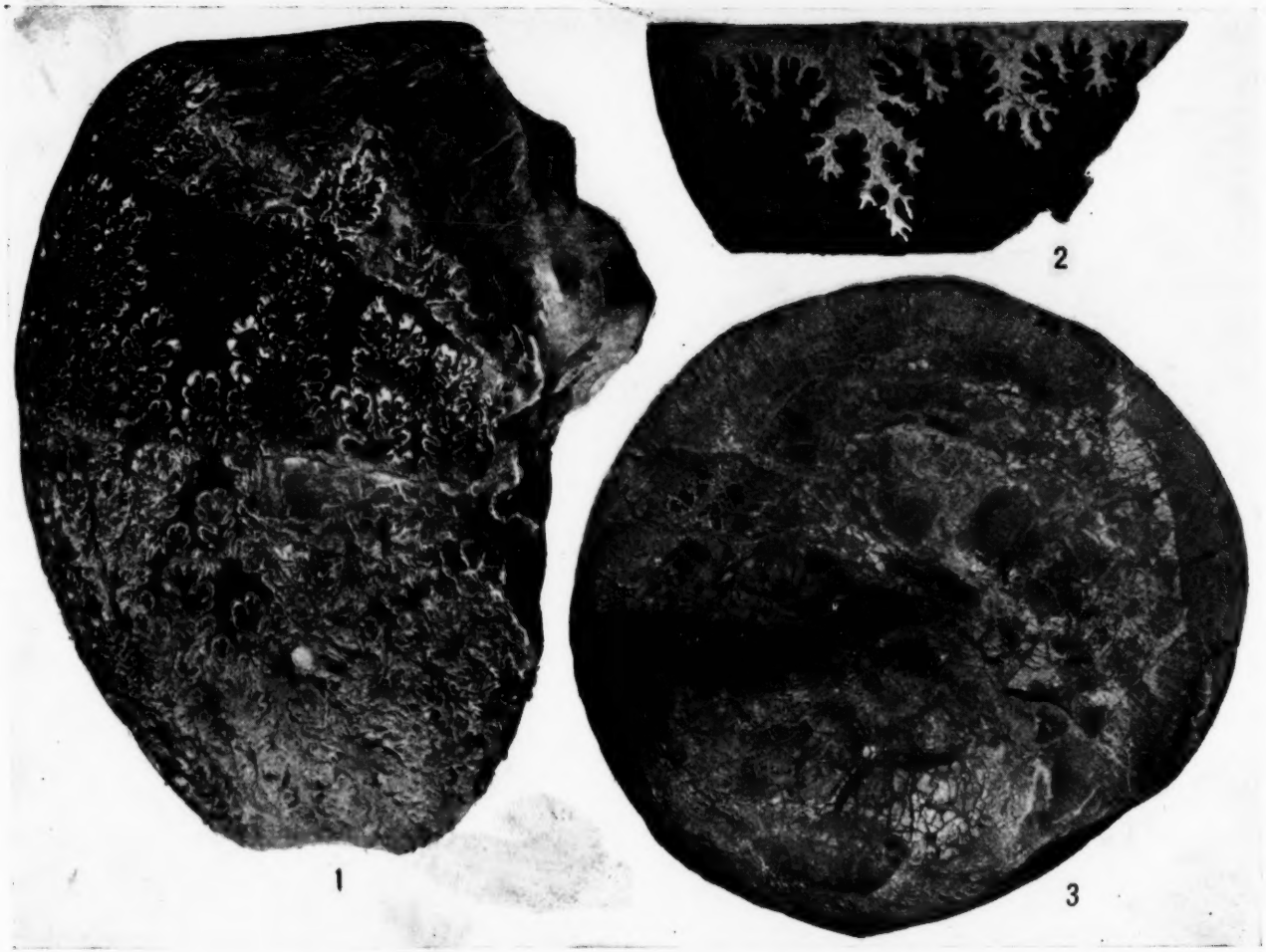
Strata of Cretaceous age are widespread in the lower Mackenzie valley. Though never mapped in any detail, our present knowledge of their distribution is shown on Geological Survey of Canada map no. 1277. The strata consist of sandstone and shale, at least 600 feet in thickness, that are in certain places or at certain horizons fossiliferous. Although fossil collections have been obtained, apparently no fossils of stratigraphic value have been recognized until now, as no designation of exact age has been applied to the beds. It is the purpose of this communication to show that part, at least, of the lower Mackenzie Cretaceous is Aptian in age, a determination based on the presence of the ammonite genera *Beudanticeras* and *Deshayesites*.

THE FAUNA

Various specimens and collections of pelecypods and ammonites from the lower Mackenzie Cretaceous have been presented to the Department of Geology of the University of Alberta. The pelecypods appear to be mostly new or little known species and are of little value as index fossils. The ammonites, though generally fragmentary and poorly preserved, can usually be identified, and they have definite stratigraphic value. The following species have been determined:

(a) From the north shore of Keith arm (west arm) of Great Bear Lake. *Beudanticeras* cf. *B. affine* (Whiteaves).

(b) From Mackenzie river, 4 miles south of Carcajou rock below Fort Norman. *Beudanticeras* cf. *B. affine* (Whiteaves), *Deshayesites mcconnelli* (Whiteaves), *Deshayesites* aff. *D. mcconnelli* (Whiteaves).



FIGS. *1–3*—*Beudanticeras* cf. *B. affine* (Whiteaves). *1*, Septate portion of a whorl, ×0.8; Univ. Alberta Dept. Geol. Mus. Ct. 253. *2*, Fragment of whorl, ×0.4, showing suture; U.A.D.G.M. Ct. 281. *3*, Specimen, ×0.4, in ironstone nodule; the periphery is eroded off; U.A.D.G.M. Ct. 779. (p. 71)

The specimen of *Beudanticeras* from Great Bear Lake (U.A.D.G. Mus. Ct. 779), presented by L. H. Vieweger, is the most complete specimen in the collection. It is preserved in an ironstone nodule, squeezed laterally and crossed by many cracks which have been infiltrated with silica. The edge of the shell has been eroded and now conforms to the shape of the nodule. In spite of these conditions the suture was satisfactorily worked out. As in most examples of the genus *Beudanticeras*, the sutures are crowded together and interlock considerably, thus obscuring most of the finer detail. The main features of the large, asymmetrical lateral lobe are well shown, however, which, together with the smooth discoidal, involute type of shell leaves little doubt that the ascription of the species to Hitzel's genus *Beudanticerus* is justified. The periodic constrictions of growth so often characteristic of the genus cannot be observed on this specimen, perhaps owing to the crushed condition of the shell. The species represented is probably *B. affine* (Whiteaves) (5), but as Whiteaves' species undoubtedly require revision, definite specific relationships cannot be presented at this time. The very wide stem, or mouth, of the lateral lobe of the suture of this specimen should be noted (Text-fig. 3).

The specimens from Mackenzie River below Fort Norman are fragmentary. The fragments ascribed to the genus *Beudanticeras* show a great range in size of the original specimens. The largest must have been at least 10 inches in diameter and the smallest about 2 inches. If we include the specimen described by Meek as *Ammonites billingsi* (2*a*), probably from this general vicinity, in the genus *Beudanticeras*, a still smaller size is indicated. It is probable that more than one species is represented by these fragments.

The fragments of the smaller specimens are from the living chambers, as no sutures are present. The fragments of the larger specimens are from the septate portion of the shells. One fragment (U.A.D.G. Mus. Ct. 282), which represents a specimen of size similar to that from Great Bear lake, shows the periodic restrictions of growth very plainly, but the sutures are so crowded together that they are nearly useless for purposes of identification. It does show, however, an asymmetrical lateral lobe, the mouth of which is wide. Another specimen of similar size (U.A.D.G. Mus. Ct. 281) shows no constrictions of growth, and the mouth of the lateral lobe is much more restricted (Text-fig. 2). Another specimen of the same genus in our collection (U.A.D.G. Mus. Ct. 253), from Dorothy, Alberta, undoubtedly derived from glacial drift, shows the periodic constrictions of growth and a suture quite similar to that of the specimen from Great Bear lake that does not show the constrictions (Text-fig. 1). It is quite probable that the presence or absence of constrictions of growth is of little specific value, but the differences in the shape of the lateral lobe of the suture displayed in these specimens probably indicate that we are dealing with more than one species of *Beudanticeras*.

The other ammonites found at this locality on Mackenzie River are referable to Whiteaves' species *Hoplites mcconnelli* (5*a*), which form has since been cited by Spath as a *Deshayesites* (6). The septate portions of the shells are not sufficiently well preserved to show the suture, but the shape and ornamentation of the specimens are sufficiently characteristic, as well as their association with *Beudanticeras*, to leave little doubt as to their identity. It is probable that more than one species is represented.

AGE AND CORRELATION

The occurrence of *Beudanticeras* and *Deshayesites* in the lower Mackenzie Cretaceous serves to correlate the containing beds with the Loon River shale and the lower part of the Peace River sandstone on Peace

Ct. 253. 2, Fragment of whorl, ×0.4, showing suture; U.A.D.G.M. Ct. 281. 3, Specimen, ×0.4, in ironstone nodule; the periphery is eroded off; U.A.D.G.M. Ct. 779. (p. 71)

River, and with the Clearwater shale and the lower part of the Grand Rapids sandstone on Athabaska River, Alberta, in which formations a similar fauna has long been known to occur (5). The exact dating of this fauna has recently been accomplished by McLearn (7) who places it in the Aptian. The writer concurs with this finding, which also fixes the age of the fauna described above from the lower Mackenzie.

On Athabaska River the *Beudanticeras-Deshayesites* fauna is preceded and followed by other faunas of Lower Cretaceous age. The ammonnites of the higher faunas have already been studied in detail by McLearn (8). No representatives of the succeeding or preceding faunas have yet come to hand from the lower Mackenzie River, though in all probability such faunas must be present there, for the sea containing these faunas must have invaded the continent from the Arctic, and little relationship exists between the faunas of the sea which deposited sediments in Alberta and the Mackenzie valley and those of the seas which invaded North America at this time from the Gulf of Mexico or the Pacific.

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NEW GENERA OF MESOZOIC AND CENOZOIC CORALS

JOHN W. WELLS
Homer, New York

ABSTRACT

Seven new generic names are proposed to replace preoccupied names, one each in the Triassic and Cretaceous faunas, three in the Tertiary, and two in the Recent. Five new genera are instituted, one each in the Triassic, Jurassic, and Cretaceous, and two in the Tertiary; and one new subgenus in the Recent.

The new genera and generic names offered here arise from work on the madreporarian hexacorals supported by a grant to Dr. T. Wayland Vaughan from the Penrose Bequest of the Geological Society of America. Seven of the new terms proposed are substitutes for preoccupied names, five apply to new generic groups, and one to a new subgeneric group.

SYSTEMATIC DESCRIPTIONS

Genus ACANTHELIA Wells, n. name

Acanthopora Verrill, 1864, not D'Orbigny, 1849.

Genotype: *Echinopora horrida* Dana, 1848. Recent; Fiji Islands. Type in U. S. Nat. Mus.

This genus is separable from *Echinopora* by the form and structure of the corallum. In *Echinopora* the corallum is massive, foliate, or explanate, with vesicular peritheca; in *Acanthelia* the corallum is ramose or dendroid, with solid peritheca, the corallites filling up completely from below.

Dana's (1) figures of the type species, at present unique, are very good.

Genus GRUMIPHYLLIA Wells, n. name

Grumia Oppenheim, 1899, not Alphéraky, 1892.

Genotype: *Grumia diploctenium* Oppenheim, 1899. Mid-Oligocene; Monte Grumi, near Castelgomberto, Vicentin, Italy.

Similar in form to *Diploctenium*, but with dentate septa as in *Favia*, and no columella. A member of the *Faviidae*.

The type species (2) is unique.

Genus STROTOGYRA Wells, n. gen.

Genotype: *Rhipidogyra undulata* Reuss 1854. Senonian; Nefgraben, Gosau, Austria.

This genus contains Upper Cretaceous species formerly placed in *Rhipidogyra* E. and H. The latter is confined to the Upper Jurassic and Lower Cretaceous and forms, together with several contemporary genera, a separate family group.

Strotogyra is characterized thus: Colonial, colony-formation by intramural linear polystomodaeal budding, forming a pedunculated contorted uniserial corallum, free laterally. Epitheca occasionally developed. Costae bifurcating, distinct to base. Septa exsert, numerous, nondentate on upper margins. Columella usually continuous, lamellar, thin, attached to processes from inner edges of septa.

Rhipidogyra has a coarser corallum with obsolescent costae. *Placosmilia* is the monostomatous form of *Strotogyra*, and has non-bifurcating costae. *Pachygyra* is the more massive form of *Strotogyra*, in which the series are united laterally by costae and exotheca.

Besides *R. undulata* Reuss (3), the new genus includes *R. poseidonis* Felix (4) and *R. turonensis* De Fromentel (5).

Genus KOLOGYRA Wells, n. gen.

Genotype: *Pachygyra tuberosa* D'Orbigny, 1850. Upper Jurassic, Rauracian; Châtel-Censoir (Yonne), France. Type, Mus. Nat. Hist. Nat., Paris, Coll. D'Orbigny 4551.

This name is proposed for a form whose position is intermediate between *Aplosmilia* D'Orbigny and *Acanthogyra* Ogilvie. It differs from the former by its massive corallum with corallites united to within a short distance of the calices by peritheca, the surface of which is non-costate and granulated; and from *Acanthogyra* by the presence of the peritheca. It differs from both genera also by the polystomatous calicular series in earlier stages of colony-formation, followed by permanent monostomatous to tristomatous conditions.

The genus was derived from *Aplosmilia* by the polyps not becoming organically separated, evidenced by the development of peritheca. *Acanthogyra*, in turn, was derived from *Kologyra* by the corallites being united directly by their walls without the intervention of peritheca.

The type species is at present unique.

Genus KÜHNOPHYLLIA Wells, n. gen.

Genotype: *Thamnastrea centrifuga* Reuss, 1869. Lower Oligocene, Ligurian; Crosara (Venezia), Italy.

This genus includes certain Tertiary *Dimorphastrea*-like forms with the characters of the family group, which includes *Dimorphophyllia*, *Heterogyra*, *Colpophyllia*, and *Spinellia*—forms in which a definite mural structure is replaced by dissepimental tissue, colony-formation is by intratentacular budding, calicular centers united by lamellae, epitheca absent, and septa regularly and finely dentate. The main distinctions between the genera involved are based upon the mode of colony-formation, as outlined below:

Kühnophyllia.....Circumoral budding, absence of collines.

Dimorphophyllia..Circumoral budding, followed by intramural budding, collines present, with ambulacra.

Heterogyra.....Intramural budding, collines and ambulacra present.

Colpophyllia.....Intramural budding, collines but rarely ambulacra, valleys often discontinuous.

Spinellia.....Intramural budding, adjacent valleys not united, curving upwards to form foliaceous corallum.

The term *ambulacrum* is here used to designate the valley lying between the individual walls of double collines of adjacent calicular series. When a single colline separates adjacent series, no ambulacrum is present.

Other species of *Kühnophyllia* are *Dimorphastrea exigua* and *D. pulchella* Reuss 1869 (6), both from the Crosara Oligocene.

Genus PARAHALOMITRA Wells, n. name

Text-figures 4–6

Doederleinia Gardiner, 1909, not Steindachner, 1883.

Genotype: *Halomitra irregularis* Gardiner, 1898. Recent; Funafuti.

The characters separating this genus from the closely related *Halomitra* are inconspicuous but sufficient. *Halomitra* is derived from the group of *Fungia fungites* in which the compound septal trabeculae are composed of pinnately arranged elements, resulting in sharp, smooth dentations on the septal margins; and the costal spines are simple, conical, and but faintly hirsute (text-figs. 1–3). *Parahalomitra irregularis* (7) is derived, together with *Podabacia*, from the group of *Fungia repanda*, in which the trabeculae are composed of irregularly diverging elements, resulting in irregular, often long, dentations; and the costal spines are granulose and often dividing near the base (arborescent) (text-fig. 2).

Genus PROGYROSMILIA Wells, n. name

Coelocoenia Gerth, 1923, not Volz, 1896.

Genotype: *Coelocoenia torulosa* Gerth, 1923. Miocene; Java.

Progyrosmilia is proposed in place of Gerth's *Coelocoenia* (8), which has been pre-occupied by Volz for a Triassic coral.

Kühn (9) has recently placed *Coelocoenia* Gerth in the synonymy of *Dichocoenia* E. and H., an unrelated genus confined to the West Indian region and California Tertiary, and in which the peritheca is typically a heavy, sometimes solid, deposit. On the other hand, the corallum of the Malaysian form is light, with vesicular peritheca. The lightness of the corallum is like that of *Gyrosmilia* E. and H., to which it seems to be closest. The main distinction between *Gyrosmilia* and *Progyrosmilia* is that in the former the walls of adjacent valleys are closely united, while in the latter they are separated by ambulacra, across which the costae extend; there are also no costae across the ambulacra in *Dichocoenia*.

Genus PROTOHETERASTREA Wells, n. name

Hexastraea Volz, 1896, not Sismonda, 1871.

Genotype: *Hexastraea leonhardi* Volz, 1896. Upper Triassic, Karnian; St. Cassian, Southern Alps. Types in University of Breslau.

A second species is *Hexastraea fritschi* Volz, also from the St. Cassian beds.

The Liassic genus *Heterastreaea* Tomes (10) was derived from *Protoheterastrea* by the union of the corallites to form a massive rather than fasciculate corallum. Both genera belong to the Stylophyllidae.

Genus REUSSANGIA Wells, n. name

Stylangia Reuss, 1874, not De Fromentel, 1867.

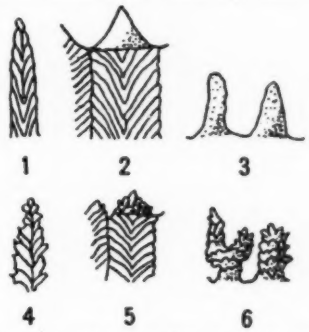
Genotype: *Stylangia elegans* Reuss, 1874. Eocene (Lutetian); San Giovanni (Venezia), Italy.

This name is proposed for *Stylangia* Reuss which is preoccupied by De Fromentel's earlier genus. *Reussangia elegans* (11) is close to *Cladangia*, but may be differentiated by the costate rather than granular or striate peritheca, and by the styliform rather than parietal columella.

Genus REUSSOPSAMMIA Wells, n. gen.

Genotype: *Stereopsammia granulosa* Reuss, 1864. Middle Oligocene; Welscherge, near Waldböckelheim, Rheinland, Germany.

This name is proposed for a eupsammid coral closely resembling *Lobopsammia* E. and H., in form, but differing by lack of a columella and by the septal



FIGS. *1–3—Fungia fungites. 1, 2.* Transverse and tangential sections of compound trabecula, ×9. *3,* Costal spines, ×4. Characteristic of *Halomitra.*

4–6—Fungia repanda. 4, 5, Transverse and tangential sections of compound trabecula, ×4. *6,* Costal spines, ×4. Characteristic of *Parahalomitra.*

arrangement, which does not follow the "Duerden-Pourtalés Law," as it does in most of the Eupsammiidae, but is normal, at least in the adult stage. *Stereopsammia* increases by extratentacular budding and forms low colonies, whereas intratentacular budding in *Reussopsammia granulosa* (12) produces branching coralla.

Genus OCULINA Lamarck
Subgenus SCHIZOCULINA Wells, n. subgen.

Subgenotype: *Oculina fissipara* E. and H., 1850. Recent; Cape Natal, West Africa.

The distinction between *Schizoculina* and *Oculina*, s.s., is that colony-formation takes place by intratentacular rather than extratentacular budding.

Besides the subgenotype, the other species of *Oculina* in the West African coral fauna, *O. arbuscula* Gravier (not Agassiz) (13) and *O. africana* Thiel (14), also increase by "fissiparity." It is not certain, however, that these three species are distinct. Another genus that normally increases by extratentacular budding which is represented in the West African fauna by a fissiparous subgenus is *Cladocora*. Duncan's type of *Dendrocora fissipara* (15) came from a locality off Bonito, at a depth of 4½ fathoms. It may also be pointed out here that Gravier (13*a*) has figured, under the name "*Favia fragum* Esper," a specimen of a fissiparous *Siderastrea* that is distinct from the other specimens of this genus described in the same paper.

Genus TAXOGYRA Wells, n. name

Heterophyllia D'Orbigny, 1849, not McCoy, 1849.

Genotype: *Meandrina macroreina* Michelin, 1847. Turonian; Soulage (Aude), France. Type, Mus. Nat. Hist. Nat., Paris, Coll. Michelin.

McCoy's genus antedates D'Orbigny's use of the same name by several months and refers to a Paleozoic coral. D'Orbigny's *Heterophyllia* has usually been considered a synonym of *Meandrastrea* D'Orbigny, but a study of the type specimens of the genotypes of both genera, preserved in the Paris museum, shows that they are distinct, although belonging to the same family. *Meandrastrea pseudomeandrina* (Michelin) (16) is a non-meandroid coral with monostomatous calices resulting from intratentacular budding. *Taxogyra macroreina* (16*a*) also increases by intratentacular budding, but on the polystomodaeal intramural mode, resulting in long sinuous series. It was derived from *Astrogyra* Felix by the suppression of the interserial exotheca and costae, the walls of the adjacent series being closely united to form simple collines.

Genus THIGMASTREA Wells, n. gen.

Phyllocoenia Frech, 1890, not E. and H.

Genotype: *Phyllocoenia grandissima* Frech, 1890. Upper Triassic, Zlambach beds, Norian; various localities in Upper Austria.

The *Phyllocoeniae* of the Upper Triassic have no affinities with the species of *Phyllocoenia* (= *Montastrea*) of the later Mesozoic and Tertiary. They are forms closely related to the Triassic *Thecosmiliae*, from which they differ by their more massive growth-form resulting from incomplete separation of the corallites after intratentacular budding. The latter is usually monostomatous and complete, as in *Favia*. These forms are here called *Thigmastrea*.

Besides *T. grandissima* (17), the following species are also included in the genus: *T. kokeni* (Frech) (17a), *T. decussata* (Reuss) (17*b*), and *T. incrassata* (Frech) (17*c*), all from the Zlambach beds.

In many of Frech's figures of these species the corallites appear to have no mural structures; they were replaced by dissepiments, as is common in *Thecosmilia*. The calices on well-preserved specimens show distinct boundaries, with the costae extending across the intercorallite spaces. The Triassic *Isastreae* described by Frech belong in the group of *Thecosmilia* and *Thigmastrea*, and are nearest the latter, distinguished by the complete fusion of the corallite "walls" and frequent intramural budding which produces short meandrine series. Species showing the latter condition were placed in a subgenus "*Latimaeandra*" by Frech. It is probable that these Triassic *Isastreae* are not congeneric with the later Jurassic *Isastreae*, but should be placed in *Elysastraea* Laube, perhaps with a new subgeneric designation for the meandrine forms. The latter certainly have no affinities with the Upper Jurassic *Latomeandra*.

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Note: The manuscript of this paper was received by the editor August 28, 1936.

PALEONTOLOGICAL NOTES

UNUCHINIA, NEW NAME FOR *APATOR* SIMPSON, NOT SEMENOW

GEORGE GAYLORD SIMPSON
The American Museum of Natural History, New York, New York

Mr. Paul H. Oehser has called my attention to the fact that the name *Apator*, recently proposed by me for a genus of Paleocene mammals (Am. Mus. Nat. Hist., Novitates, no. 837, p. 16, 1936), is preoccupied by *Apator* Semenow, 1898, in Coleoptera. I therefore propose to substitute for *Apator* Simpson, not Semenow, the new generic name *Unuchinia*, the genotype becoming *Unuchinia asaphes* (Simpson, 1936).

COOPERATIA, NEW NAME FOR *COOPERIA* TOLMACHOFF, NOT RANSOM

I. P. TOLMACHOFF
Carnegie Museum, Pittsburgh, Pennsylvania

Some time ago Mr. Paul H. Oehser, U. S. National Museum, noted that the name *Cooperia*, introduced by me for a genus of Devonian ostracodes (On the fossil faunas from Per Schei's series D from Ellesmere Land: 2d Norw. Arct. Exped. *Fram* 1898–1902, Rept., no. 38, p. 34, 1926), had been used previously by Ransom for a genus of nematodes (Ransom, B., U. S. Dept. Agric., Bur. Animal Ind., Circ. 116, p. 3, 1907). The new name *Cooperatia* is now offered in substitution for *Cooperia* Tolmachoff, not Ransom. The genotype becomes *Cooperatia granum* (Tolmachoff). The new name is introduced following the kind advice of Dr. A. S. Warthin, Jr., of Vassar College, to whom thus partially belongs the role of godfather in rechristening my genus.

CAMBROTROPHIA, NEW NAME FOR *EOSTROPHIA* ULRICH AND COOPER, NOT DALL

EDWARD O. ULRICH and G. ARTHUR COOPER
U. S. National Museum, Washington, D. C.

Messrs J. F. Mason and P. H. Oehser have called our attention to the fact that the name *Eostrophia*, proposed by us for a brachiopod (Jour. Paleontology, vol. 10, no. 7, p. 627, 1936), was used by Dall in 1890 in the Transactions of the Wagner Free Institute. This earlier use of the name by Dall for a fossil gastropod makes a new name necessary for our brachiopod genus. We therefore propose the name *Cambrotrophia* for the invalid term. The genotype thus becomes *Cambrotrophia cambria* (Walcott).

SOCIETY RECORDS AND ACTIVITIES

PALEONTOLOGICAL SOCIETY: OBITUARY

The Paleontological Society records with regret the death during 1936 of three Fellows. These are:

August Frederick Foerste, died April 23, 1936.

Jesse Earl Hyde, died July 3, 1936.

William Arthur Parks, died October 3, 1936.

Memorials of these Fellows will appear in the Proceedings of the Geological Society of America for 1936.

ANNOUNCEMENT OF THE ELEVENTH ANNUAL MEETING OF THE SOCIETY OF ECONOMIC PALEONTOLOGISTS AND MINERALOGISTS

The eleventh annual meeting of the Society of Economic Paleontologists and Mineralogists will be held in conjunction with the twenty-second annual convention of the American Association of Petroleum Geologists at the Biltmore Hotel in Los Angeles, California, March 17–19, 1937.

Mr. Stanley G. Wissler, Union Oil Company, Box F, Compton, California, has been appointed chairman of the program committee. All titles and abstracts of papers to be presented should be sent to him. Mr. Herschel L. Driver, Standard Oil Company, Los Angeles, California, is chairman of the arrangements committee.

CARBONIFEROUS OSTRACODES—A Correction

BETTY KELLETT

Through an error in the make-up of page 770, this Journal, Vol. 10, no. 8, December, 1936, much confusion is introduced in synonymies of *Paraparchites*. The following re-publication, with headings in correct position, shows treatment of forms as intended.

SYSTEMATIC DESCRIPTIONS

Family LEPERDITELLIDAE Ulrich and Bassler, 1906

Genus PARAPARCHITES Ulrich and Bassler, 1906

Paraparchites ULRICH and BASSLER, *1906*, U. S. Nat. Mus., Proc., vol. 30, pp. 149, 150.—GRABAU and SHIMER, *1910*, North Am. Index Fossils, p. 343.—HARLTON, *1929*, Am. Jour. Sci., ser. 5, vol. 18, p. 254.—KELLETT, *1933*, Jour. Paleontology, vol. 7, p. 63.—LATHAM, *1932*, Roy. Soc. Edinburgh, Proc., vol. 57, pt. 2, p. 353.—UPSON, *1933*, Nebraska Geol. Survey, Bull. 8, p. 11. BASSLER and KELLETT, *1934*, Bibl. Index Paleozoic Ostracoda, p. 16.

Antiparaparchites CORYELL and ROGATZ, *1932*, Am. Midland Naturalist, vol. 13, p. 387, pl. 34, figs. 3, 4 (see explanation pl. 35).

The genus *Antiparaparchites* Coryell and Rogatz was based on the single species *A. reversus* and was originally described:

Antiparaparchites differs from *Paraparchites* in the reversal of orientation of carapace; left valve overlaps right along free border of *Antiparaparchites;* reversed in *Paraparchites.*

An examination of the holotypes of *A. reversus* Coryell and Rogatz and *Paraparchites oviformis* Coryell and Rogatz, which occurred together, and also of topotype material in which both of these species are abundant, shows the two forms to be identical except for the reversal of the overlap and hinge structure. Because it is now known that such reversal of overlap within a species is not uncommon among ostracodes it is reasonable to suppose, as suggested by Johnson (1936, p. 7), that these two forms are not only congeneric, but also conspecific, and that *Antiparaparchites* is a synonym of *Paraparchites.* Similar reversals of valve size and hinge structure within a species have been noted in post-Paleozoic genera by Terquem (1886, p. 99) and by C. I. and C. W. Alexander (1933, pp. 280–283, text-figs. 1–4), and in Carboniferous *Sansabella* by Morey (1935, p. 476) and by Johnson (1936, p. 7).

PARAPARCHITES OVIFORMIS Coryell and Rogatz

Paraparchites oviformis CORYELL and ROGATZ, *1932*, Am. Midland Naturalist, vol. 13, p. 387, pl. 34, figs. 1, 2 (see explanation pl. 35). Arroyo formation, Clear Fork group, Permian; Tom Green County, Texas. (Type examined.)

Antiparaparchites reversus CORYELL and ROGATZ, *1932*, Am. Midland Naturalist, vol. 13, p. 388, pl. 34, figs. 3, 4 (see explanation pl. 35). Arroyo formation; Tom Green County, Texas. (Type examined.)

PARAPARCHITES THOMASI Coryell and Sample

Paraparchites thomasi CORYELL and SAMPLE, *1932*, Am. Midland Naturalist, vol. 13, p. 248, pl. 24, fig. 1. (Type examined.)

Paraparchites palopintoensis CORYELL and SAMPLE, *1932*, Am. Midland Naturalist, vol. 13, p. 248, pl. 24, fig. 4. (Type examined.)

Paraparchites brazoensis CORYELL and SAMPLE, *1932*, Am. Midland Naturalist, vol. 13, p. 249, pl. 24, fig. 5. (Type examined.)

Paraparchites oblongus CORYELL and SAMPLE, *1932*, Am. Midland Naturalist, vol. 13, p. 250, pl. 24, fig. 3. (Type examined.)

The specimens on which the above species were based range in length from 0.37 mm. to 0.56 mm. and are all from the East Mountain shale at Mineral Wells, Texas. I am convinced that they all belong to the same species, the smaller specimens being the earlier molts. The small specimen called *P. thomasi* has the oblique anterior and prominent spine which are quite characteristic of other young *Paraparchites*, for example, *P. humerosus* (see Kellett, 1933, pl. 13, figs. 1–12). The other specimens with progressive size are straighter ventrally and less oblique at the ends, while the growth of the spine does not keep pace with the rest of the valve. Such changes in successive molts are typical of species of the genus *Paraparchites*, and are seen also in the development of *P. latidorsatus* Warthin, see page 779.